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TUBERCULOSIS OF THE KIDNEY.*

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TUBERCULOSIS of the urinary tract in by far the greatest number of cases proceeds from the one kidney, and the chances for complete recovery in such cases by surgical means are as a rule the best possible, provided this diagnosis is made at a sufficiently early stage—that is, before the tuberculosis has spread to the bladder and beyond. But the diagnosis, alas, is but too often made at an exceedingly late stage, a statement well illustrated by the fact that out of my 200 patients 40 were absolutely too far gone for operation and in an utterly hopeless condition, and that no less than 65 per cent. of the patients, where I still found indication for nephrectomy, had already tuberculosis in the bladder.

What are the causes of this deplorable fact? In a certain number of cases symptoms of cystitis, as a matter of fact, are the first indication to the patient that he is ill and take him to the physician, and under these circumstances, therefore, the latter is blameless. But in many cases, about 60 per cent. in my statistics, pains in the region of the kidneys, emaciation,

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weariness, turbidity of the urine, have, long before the bladder symptom set in, caused the patient to consult a physician, who has then made a *wrong diagnosis.* The wrong diagnosis is most frequently *nephritis,* under which diagnosis many of my patients have been treated for a lengthened period even by clever physicians, and, worse still, in medical hospital wards. In the urine, which is often but very slightly turbid, the ordinary chemical tests show a faint or medium albumin reaction which is diagnosed as arising from a nephritis, and a rigorous diet, milk, milk foods, fish, is then ordered—a fatal mistake, especially here, because the patient's power of resisting the tuberculosis is materially weakened by this protracted scanty fare, and the disease advances rapidly.

It is generally assumed and I myself once cherished the conviction that with every surgical tuberculosis of the kidney, even in the earliest stage, *albuminuria* must occur, and that one would therefore be justified in excluding the diagnosis of tuberculosis of the kidney when the examination of the urine for albumin gives a negative result. But of late years, a series of observations has shown me that this is not the case, as we meet with some cases where the albuminuria is intermittent and with others where it seems to be invariably absent.

Among my cases, some 200 in number, I have established the diagnosis seven times in such circumstances.

In reality, cases of this sort are undoubtedly far more frequent, because just the belief of the necessity of albuminuria with tuberculosis of the kidney has surely resulted in most physicians not having thought of or searched for tuberculosis in such cases. I have therefore thought it of importance to collect these cases in a tabular form with a short extract of the histories of the disease, and to examine what they teach us, especially as regards the circumstances in which the albuminuria fails to appear and those other symptoms which may lead to a correct diagnosis.

Case I concerns a man who, on account of albuminuria, was treated in a medical ward during nine months for chronic

nephritis. The albuminuria having ceased, it was thought that the man was cured of the nephritis and he was consequently discharged. A day or two afterward he was admitted to my clinic, without question free of albuminuria, but, as was clearly substantiated, with an enormous tumor on the right side of the abdomen, which proved at the ensuing operation to be the right kidney, which was completely destroyed by infiltrating tuberculosis, so that literally no kidney tissue was found, this being replaced everywhere by a cheese-like mass. No pus was found, the mucous membrane of the ureter was certainly very inspissated, but there was no talk of obliteration.

This is, then, an interesting example of how the urine can in extremely advanced cases be free of albumin without the ureter being closed, apparently because all secreting kidney tissue is destroyed. But in most cases the absence of albuminuria has occurred where the tuberculosis of the kidney is of relatively recent date or is strictly limited. It is clear that such cases arrive in the surgeon's hands only when they present other conspicuous symptoms. In a group consisting of three cases (Tables 3, 4 and 5) it was hæmaturia, with or without pains, which brought them to me.

The first case (Case III) was very interesting, partly because the symptoms had existed during five years, and partly because, even with the removed kidney under our eyes, the diagnosis was doubtful. The patient was a woman of thirty years, who, five years previously, had suddenly begun to suffer from left-sided pains in the loins and from hæmaturia. The hæmaturia lasted only for four days, but the pains continued during the following 11 months; the result being that she was daily treated with morphia at the infirmary where she lay. During the following three years she was free of pain, but then the attacks of pain and hæmaturia recommenced. No trace of albumin was found in the urine, and leucocytes were found only occasionally, while we did not succeed in proving the presence of tuberculous bacilli. At the operation on June 3, 1908, I found a whitish-yellow tumor, the size of a nut, protruding from the middle third of the kidney. When the kidney was split, it was seen that the tumor

mentioned consisted of pork-like, whitish tissue which did not resemble the recognized aspects of tuberculosis, and, furthermore, the upper and lower kidney papillæ were found to be infiltrated with similar tumor tissues. The diagnosis vacillated between carcinoma and gumma, but the microscope revealed typical tuberculosis.

That this tuberculosis which so peculiarly resembled tumor did not involve albuminuria can be explained without any great difficulty. It is more difficult, however, to understand Cases IV and V, showing themselves during a long-lasting examination to be free of albumin, because, in both cases, abscesses and miliary tubercles were found in the kidney at the operation.

With Case IV, a little girl nine years old, the hæmaturia was severe but painless, and the only symptom left which could be relied upon was the discovery of leucocytes in the urine. On the other hand neither tuberculous bacilli nor albumin were found. With Case V, however, the hæmaturia was associated with pains in the discharge of the urine, and, as a considerable tuberculosis of the prostate and ulcerations in the bladder were found—though no albumin—it was most natural to think that an ascending genital tuberculosis was in question, but it was not until, at the catheterization of the ureter, leucocytes and tuberculous bacilli were found in the albumin-free urine from the left kidney that suspicion was centred on this.

With Cases II and VII it was only the attacks of pain occurring in the region of the left kidney which brought the patients to me. With Case II, all that I had whereon to found my suspicion of tuberculosis was the pus-celled contents of the urine, without my being able simultaneously to prove the presence of microbes of any sort. With Case VII the diagnosis was rendered still more difficult by my finding in the urine of the bladder, in addition to the pus-cells, some Gram-positive coccobacilli. It was only at the catheterization of the ureter, when it appeared that the urine from the left kidney contained pus-cells without microbes, that a suspicion of tuberculosis was aroused, and then, by persistent investigations, one succeeded in finding tubercle bacilli.

Finally, with Case VI, a patient was concerned on whom I had several years before performed a right-sided castration for tuberculosis in testis and epididymis, and who was now admitted with tubercular left-sided epididymitis. There was no albumin in the urine when he was admitted, but as later on a little was occasionally found, I made a cystoscopy, and then found a small ulceration in the bladder medially before the orifice of the right ureter, and as at the catheterization of the ureter leucocytes were found in the urine of the right kidney, an exploratory lumbar incision was made. At the operation I was surprised to find the entire kidney degenerated by small cysts, without there being any microscopic signs of tuberculosis, while on the other hand a stricture was found in the ureter. After the removed kidney had been cut through, only the aspect of a cystic kidney was to be observed macroscopically, but, scattered in this, the microscope revealed small tubercular foci.

Then there are the cases where the urine contains visible pus and where the diagnosis is pyelitis, and the patient is then treated with salol, boracic acid, or similar remedies. But even the symptoms of cystitis do not by any means always bring the physician on the right track. The only result is that he often, without a more thorough examination as to what form of cystitis he has here to deal with, blindly attacks, so to speak, the disease with the ordinary cystitis remedies—such as nitrate of silver injection, which is exceedingly painful, entirely useless, and often apparently aggravates the cystitis. These patients are in a still worse plight if a short time previously they have been suffering from gonorrhœal urethritis, because the cystitis is then taken to be gonorrhœal and treated with protargol or, what is still much worse, with the Janet daily lavage with a solution of permanganate of potash, which appears to have a particularly injurious effect upon the mucous membrane of a tuberculous bladder; this treatment, at all events, appears to have had a fatal influence in two of my cases.

All these regrettable errors in diagnosis might be avoided if only physicians fully realized that one ought never to begin the treatment of albuminuria, pyuria, or cystitis without first

having subjected the urine, sterilely taken from the bladder, not only to a chemical but also to a microscopical and bacteriological examination.

I am quite aware that it is maintained to be very difficult to prove the presence of tubercle bacilli; even in the newest hand-books, such as Küster's and Wagner's, it is stated that attempts to show the presence of tubercle bacilli in diseases of the urinary tracts only succeed in 10–20 per cent. of the cases. With reference to these statements I can only say that the gentlemen in question must have adopted unfortunate methods or have not persevered long enough, for when I make up the statistics from all my cases it appears that the assured presence of tubercle bacilli has been successfully shown in 80.7 per cent. of these cases. The method which I have used with such good results is that of Forsell, according to which one lets the aggregate urine of the twenty-four hours precipitate in a separator. The lowest portion of the precipitate which contains the tubercle bacilli is separated, and can then in addition be centrifugally treated before being microscoped.

For a practitioner all such circumstantial methods as a rule are entirely unnecessary, for simple microscopy with ordinary microbe coloring is sufficient to give him the diagnosis. If he finds pus in the urine but no microbes the diagnosis of the tuberculosis is almost certain; the case is so suspicious that the patient must at once be sent to a place where a special examination by experts can be undertaken, for in all suppurative kidney affections we find numerous easily colored microbes in the urine.

If we are now certain or at any rate have a strong suspicion that it is a case of tuberculosis of the urinary organs, it is necessary for us accurately to define the seat and the extent of the tuberculosis: Is it confined to the one kidney or has it attacked both? Is the bladder tuberculous, and if so, by ascending or descending infection? But the question as to what should be our principal method of deciding these vital points is a subject of strong disagreement among medical men all over the world, as Luy's and Cathelin's so-called urine segre-

gators are being advocated in preference to cystoscopy and ureter catheterization.

The use of ureter catheterization, more especially in tuberculosis of the urinary organs, has many enemies, no doubt principally on account of the art of ureter catheterization being so difficult to learn and requiring so much time, but also because one is afraid of infecting the possibly sound ureter; and even if we maintain that this risk as far as experience shows us is very slight, yet its existence cannot be denied, and it would be desirable if we could manage with cystoscopy alone or with segregators. According to my experience, this, however, is entirely impossible. Cystoscopy pure and simple is always uncertain; in some cases we can, of course, see undoubtedly purulent urine flow from the orifice of the ureter and thus be tolerably certain of the kidney in question being affected, but we are then left entirely in the dark as to the state of the other kidney, for a macroscopically clear urine is not by any means synonymous with a normal urine. What cystoscopy, generally speaking, should enlighten us about are alterations in the shape of the orifice of the ureter, swellings, miliary tubercles, and ulceration around the diseased orifice of the ureter. But you will find that the tuberculous alterations in the bladder in only a minority of the cases are localized around the diseased ureter. In some cases you will see that the bladder tuberculosis, in a directly misleading manner, has localized exclusively round the orifice of the sound ureter. You will find cases where both the kidneys are affected but both the ureteric orifices are free from alterations, or where the tuberculosis has localized round the orifice of the one ureter; but in by far the greatest number of cases you will see that bladder tuberculosis in one-sided kidney affection is spread over both sides or halves of the bladder, sometimes over the whole of the mucous membrane of the bladder. But if this capricious spreading of bladder tuberculosis makes the deductions which you can draw from simple cystoscopy most unreliable, its effect upon the results obtainable by means of Luy's and Cathelin's segregators is still more fatal, for it is a matter of course

that in all those cases of one-sided kidney tuberculosis with an opposite or extended localization of bladder tuberculosis, purulent urine containing tubercle bacilli will be drawn from both the tubes of the segregator and thus wrongfully lead to the diagnosis of double kidney tuberculosis, where in reality it is a case of only one-sided kidney tuberculosis. This is the more serious because this mistake will never be brought to light to a physician depending upon the segregator, for the patient will be sent away as unfit for operation, and when in due course he succumbs to his disease, it only seems to confirm the, in reality erroneous, diagnosis. Thus by using the method we run the risk that a certain number of patients, who could have been saved by nephrectomy, are left to their fate.

Therefore this method ought not to be allowed to take the place of or be put on a level with the ureter catheterization, which is the only bloodless method which can give us certain knowledge of the state of the kidneys, and it is necessary to warn against the use of segregators, which are so tempting because of the technical simplicity of the method, which any one can apply, whilst ureter catheterization requires special training and practice.

The examination of the urine taken from each kidney must be undertaken with great care and judgment; it must be subjected to a thorough chemical, microscopical, and bacteriological examination. If we were to content ourselves with a chemical analysis of the urine from each kidney for albumin, we might in some cases be led to suppose we had a case of double-sided kidney tuberculosis, where in reality it was only one-sided. It is of less importance that an albumin reaction can be, owing to a mixture of blood in the otherwise normal urine, caused by a traumatic injury to the mucous membrane by the point of the catheter, because in most cases one will observe the sudden blood color in the urine, but in order to make certain that the bleeding has not been caused by the ulcerated state of the mucous membrane, the urine must be carefully microscoped. *It is of greater importance to know that with severe tuberculosis of the one kidney one can have*

real albuminuria from the other, without this signifying that the latter, too, is tuberculous. In this instance it is a case of toxic albuminuria, which is caused by the blood having absorbed poisonous substances from the tuberculous kidney, and as such toxic albuminuria, instead of contraindicating an operation, requires on the contrary a speedy extirpation of the tuberculous kidney from which the poisoning proceeds, ***it will be easily apparent how important it is to be able to discern between the former and the albuminuria,*** which indicated the commencement of tuberculosis in the other kidney, and this can only be done by careful microscopical and bacterioscopical examination of the albuminous urine: if this does not contain any or only contains very few leucocytes and no bacilli, then we have to deal with a toxic albuminuria, while a real tuberculous kidney affection will always show numerous leucocytes and most frequently easily discernible tubercle bacilli, for the more recent the tuberculous affection the more numerous the bacilli. At the Congress of Surgeons held in Berlin in April, 1905, I for the first time drew attention to the importance of diagnosticating toxic albuminuria, and in my introductory address to the discussion on nephrectomy in kidney tuberculosis, I mentioned five such cases where I, in spite of a fairly pronounced albuminuria from the other kidney, had extirpated the tuberculous kidney, and afterward had seen the albuminuria disappear in the course of a very short time, the patients being cured. To this, from subsequent personal experience, I can add eight new cases.

These cases show better than anything else the supremacy of ureter catheterization from a diagnostic and prognostic point of view. The ureter catheterization and the careful examination of the urine from each kidney is as well in very early as in medium cases our principal and sure way to the diagnosis. But unfortunately there are not so very few cases where this examination is confronted with insurmountable obstacles, and this is more especially the case where the bladder, too, is attacked by tuberculosis. In the first place, the irritability of the bladder can be so great from widespread ulcerated cystitis

that cystoscopy is altogether impossible, as the bladder cannot contain the necessary quantity of fluid; and, second, there are cases where cystoscopy would otherwise be practicable were not the ureteric orifices so buried in ulcerations and swellings that it is impossible to insert the catheter. A valuable aid in finding the mouths of the ureter in such cases is Voelker's so-called chromocystoscopy, the indigo-carmine colored urine showing us the way, but the ureter catheter is often stopped at once or a little inside the orifice by a stricture which thus prevents the urine from being obtained. In about one-third of the cases complicated by bladder tuberculosis, I have been obliged for these reasons to abandon ureter catheterization. It is consequently in not a few cases that this method of examination fails even for a much experienced cystoscopist. *Shall we then leave such patients to their uncertain fate, or have we other means of preventing patients suffering from one-sided kidney tuberculosis from succumbing,* without making any attempt to help them and to prevent surgeons from committing the surgical error of extirpating the one kidney, when the other is also attacked and unable to officiate in the secretion of the urine? In my opinion there is only one fairly reliable means of attaining these ends, namely, my double exploratory lumbar incision brought out in the year 1894, by which at the same séance I lay bare both kidneys and subject them to a thorough inspection and palpation. If I find the one kidney or possibly the ureter much affected by tuberculosis, while the other kidney and ureter show normal conditions to the touch and the eye, I can with confidence extirpate the tuberculous kidney, for even if this examination does not to a certainty exclude the presence of a small tuberculous focus in the apparently sound kidney, one can make sure of its being capable of functionating. Under such circumstances it is always of great importance to draw forward the ureter on a finger for minute examination, for in cases of ascending tuberculosis the kidney can still be quite sound both to the touch and the eye; it is only the enlarged and distended ureter which betrays the presence of the disease.

The double lumbar incision has been used by me in 30 cases of 166, and I have never lost a single patient by this method. In 24 cases I ascertained the one-sidedness of the disease, which could not have been ascertained by any other means, I removed the diseased kidney, and in all cases recovery was the result; in six cases I ascertained the double-sidedness of the disease; in one case I found the kidneys healthy; in four of these I closed again without proceeding further; in two cases I undertook ureterostomy to procure relief from pains and to arrest the process of ascending tuberculosis.

One of these cases is of considerable interest. It refers to a girl, twenty-six years of age, who was brought to my ward in a very wretched state. On examination the bladder was found to be completely infected by typical tuberculosis, the mucous membrane around both the ureter orifices was ulcerated, and the insertion of the catheter was impossible into either ureter on account of stricture. By palpation the right kidney was distinctly found to be somewhat enlarged, the left kidney could not be felt, but by means of Röntgen rays a big oblong shadow was discovered corresponding to the left kidney. The picture could not decide the question as to whether this was a large calculus or, what I was inclined to assume, a calcined tuberculous kidney. I decided upon exploratory lumbar incision on the right side, whereby I made the following interesting discovery: The appearance of the kidney itself was normal, but the pelvis had expanded to the size of a tangerine orange, the ureter was distended to the thickness of a finger the upper serpentine portion of which was thin and transparent, while the ureteric wall from about the middle was found to be at an increasing rate thickened by interstitial ureteritis. I then, in the first instance, brought the ureter forward and formed a ureterostomy by a longitudinal incision on the outer side of the ureter. I carried a drain up into the pelvis and through it drew off a perfectly clear urine, free from albumin, and which microscopically only contained a few leucocytes. By sounding the peripheral portion of the ureter I found an exceedingly narrow stricture, which commenced a few centimetres above its opening into the bladder. The urine was carried through a drain, which had been inserted into the pelvis, down into a glass

by the side of the bed, and during the following days it transpired that the other kidney did not yield any urine at all but only some tuberculous pus. In the course of a few weeks I removed the left kidney, which had been completely transformed into a tuberculous putty-like substance. The ureter fistula was kept open until the bladder tuberculosis was cured by carbolic treatment, of which I shall speak later on. The passage through the ureter was then re-established, and the kidney has now for six years officiated satisfactorily.

In two cases I punctured an abscess in the kidney as large as a hen's egg.

I have not so far touched upon the importance of the different so-called kidney function examinations for ascertaining the condition of the other kidney prior to nephrectomy. My reason is this: that many years' experience and examinations, for which I and my assistant, Dr. Koch, have fully accounted in previous publications, have shown me that nothing reliable can be based upon these examinations, because the capacity of the kidney cannot at all be gauged by the work of secretion done at the moment and which is dependent upon a number of factors.

I have, ever since 1892, systematically undertaken quantitative analyses of urea with all my kidney patients prior to operation, and found that a normal secretion of urea is a safe criterion of a sufficiency of kidney tissue capable of functionating, but that on the other hand nothing can be gathered from a reduced secretion, inasmuch as the latter directly or indirectly can be owing to the diseased kidney—directly by a purely reflex effect upon the secretion of the sound kidney (renorenal reflex), indirectly by the disease actuating the functions of the whole organism. I have shown this in a whole series of cases in which the secretion of urea after the removal of the tuberculous kidney from being diminished quickly rose to normal height. While a normal secretion of urea imparts a very important and satisfactory knowledge, it is on the other hand very risky to adduce from a slighter secretion of urea that

both kidneys are inadequate; this may serve as a warning to proceed cautiously, but nothing beyond that.

With regard to all the rest of modern kidney function examinations, I have shown that these are still more unreliable than the urea analysis, for while the latter only misleads by a negative result, both chromocystoscopy (Achard's methylene-blue test, Voelker's indigo-carmine), kryoscopy and the Floridzin method are capable of misleading by positive as well as negative results. I have therefore entirely given up these artificial and complicated methods in favor of the simple and rational quantitative urea analysis, which I make by the aid of Esbach's ureometer.

PROGNOSIS AND TREATMENT.

The great change in our conception of the pathogenesis of the disease, to which I have referred, and the great advance we have made in diagnostic skill, have also caused a happy change in the treatment of urogenital tuberculosis and its prognosis. The old pessimistic conception of the prognosis and the consequent entirely passive position, therapeutically, has devolved into a more and more hopeful view of the prognosis, on account of the surprisingly favorable results which have attended the surgeon's increasingly energetic attempts at arresting and curing the disease.

In the last years the conception of the prognosis has turned so optimistic that several authors maintain that early cases of kidney tuberculosis ought to be treated conservatively, by dietetic measures and with tuberculin, while nephrectomy only should be allowed in very advanced unilateral cases.

In my opinion this doctrine is wrong and very dangerous. *First,* because we never know whether the case is early or advanced, malign or benign. Behind the slightest most unsightly symptoms may the most advanced, the most malignant tuberculosis be hid, as recently proved by some of my cases. *Second,* there exists no convincing case of tuberculous kidney

cured by conservative treatment. As now the great statistics have established that we can save 75 per cent. of all operated patients by nephrectomy, it seems quite clear that nephrectomy is indicated as soon as we have diagnosed a unilateral kidney tuberculosis. In spending the time upon conservative treatment one runs the risk of spreading the tuberculosis to the bladder and to the other kidney, and thereby destroys the possibility of a radical cure.

If we should define the position of the question at the present moment, I consider that, generally speaking, I can maintain that the possibility of a radical cure is dependent on two conditions: (1) that the point where the tuberculosis originates within the urogenital organs can be radically removed, and (2) that at least the one kidney is sound.

As far as the descending tuberculosis of the urinary tract is concerned, these two conditions of course go together; if only the one kidney is attacked there are chances for a cure by nephrectomy. With ascending urogenital tuberculosis both conditions have to be reckoned with, inasmuch as the tuberculosis here originates in the genital organs, but often secondarily spreads to the kidneys. This double and complicated state of affairs must at the outset make it probable that the prospects of a cure would be considerably slighter with ascending urogenital tuberculosis. The prognosis for ascending urogenital tuberculosis is much more serious than for descending, and this is partly owing to the fact that while primary kidney tuberculosis in the great majority of cases is one sided, secondary kidney tuberculosis is just about as often double sided as one sided, and partly to the hopeless course which a breaking through of the tuberculosis from the prostate to the bladder and urethra most frequently takes, attended by extravasation of urine, fistula formations, etc.

If, on the other hand, only the epididymis, vas deferens, and a single kidney are attacked, there is every prospect of cure through the removal of the epididymis and the diseased kidney, even if the bladder should be also attacked. This latter com-

plication, up to a few years ago, was considered so serious that it was looked upon as an absolute contraindication against operation. We know now, through numerous instances, that a slight bladder tuberculosis is frequently cured spontaneously when the place where the tuberculosis originated is removed, but even with extensive bladder tuberculosis, which excludes a spontaneous cure, there is every chance of bringing about a cure by means of my before-mentioned treatment with 6 per cent. solution of carbolic acid, with which up to the present time I have cured 34 patients.

In all the cases, where by means of the diagnostic aids which I have just described I have proved that only the one kidney was attacked, I have removed it by nephrectomy. In all, I have performed 145 nephrectomies for kidney tuberculosis with but 7 deaths—that is 4.8 per cent. mortality. There were two deaths in the first 14 cases which were performed in 1901, consequently 14.2 per cent. mortality, while there have been only five deaths out of the 131 nephrectomies performed after 1901, that is 3.8 per cent. Considering how exceedingly far advanced the disease was in the majority of these cases, I think we may look upon this as a very low mortality, and as I am of opinion that this result is owing to the method according to which I have invariably operated during the last seven years, a short description of this method may be of interest. My principle is to remove the kidney as a closed whole, so that no tuberculous virus can have a chance of infecting the lumbar incision. I use a long slanting lumbar incision, open the fat casing of the kidney at the back, loosen with great care by means of my rubber-gloved hand the kidney from its bed and possible adhesions, examine and palpate it minutely in order to verify the diagnosis, then draw the ureter forward on my bent left forefinger, tie it up in two places with strong silken thread in order to slowly burn it through with red-hot thermocautery between the silk threads about 3 cm. beneath the entrance into the pelvis. I then isolate this from the vessels in the pedicle, which is tied up with strong formalin catgut,

after which the kidney is removed by cutting through the vessels. The peripheral end of the ureter is fastened to the skin 1 cm. from the wound line, whereby I ensure the raw surface of the abdomen against any possibility of infection from tuberculosis. Formerly, when I removed as much of the ureter as possible and lowered the stump, the latter often became the starting point for an exceedingly dangerous diffused tuberculosis in the retroperitoneal tissue and in the abdomen.

In case one or both the epididymides are attacked, an extirpation of the epididymis is performed at the same or a subsequent séance, with the preservation of the testis if the latter be not attacked. As to the severed vas deferens, it is treated in a similar manner as was the ureter: it was sewn forward to the scrotal skin, where it, when the sore is otherwise healed, is kept open as a safety-valve for the tuberculous secretion, which might be in the peripheral parts and in the vesiculæ seminales. I have adopted this method in connection with nephrectomy in a large number of cases and always with good results. If there is tuberculosis of the bladder I wait some time after the nephrectomy to see whether the bladder tuberculosis will heal spontaneously, which I ascertain by every 14 days performing cystoscopy. In 14 cases spontaneous healing resulted simply in consequence of the source of the infection having been removed with the kidney; but in the remaining 34 cases there was no such spontaneous healing. Sometimes, contrary to what is generally the case, quite a small tuberculosis was seen to spread incessantly, assuming a very vicious character, but in these cases the bladder tuberculosis was, as a rule, already far advanced when the patient came into the hospital. It is these cases I have subjected to local treatment with 6 per cent. carbolic acid solution. This treatment, which to begin with is undertaken every other day, consists in first washing out the bladder with sterilized water, and then injecting 50 c.c. of freshly made, warm, 6 per cent. carbolic solution; this is allowed to remain for two to three minutes and comes away

as a perfectly milky fluid. These injections are continued until the carbolic lotion comes away fairly clear. The effect of this treatment, which as a rule manifests itself astonishingly quickly, is shown by the cessation of the pus secretion and the urine becoming clearer. By degrees, as the urine becomes clearer, the injections are made at longer and longer intervals, and discontinued when it has been shown by cystoscopy that the mucous membrane of the bladder is healed. This we can see by the ulcerations in the cystoscopic picture being replaced by smooth mother-of-pearl-like cicatricial tissue. With widespread tuberculosis a six to eight weeks' treatment is, on an average, necessary. If the patient and the doctor have the perseverance to carry through the treatment, a cure is certain, subject to two conditions: (1) that the source of infection is removed, and (2) that the tuberculosis is confined to the mucous membrane and has not spread through the walls of the bladder. It is only subject to these conditions that the adoption of this treatment can be at all recommended. The first patient treated in this way, and in whose case the tuberculosis was of an unusually vicious nature and extending over the whole of the bladder, has now been well for five years. A drawback to this method is the considerable amount of pain which it entails; but one can materially ameliorate the pain by injecting cocaine or eucaine into the bladder prior to the treatment, and after the injection giving the patient a suppository of morphia. I have only seen isolated cases of carbolic poisoning (black urine, nausea and vomiting), but these symptoms quickly subsided. When it is made plain to the patient that this treatment is the only chance, and at the same time a very great chance, of saving life and health, he as a rule submits patiently to the pain. This treatment marks a very important advance, as a considerable number of patients who would formerly have been sent away as incurable through operation may now be saved.

I have of late gone still further in my attempts to save apparently hopeless patients; as, for instance, in the case I have already mentioned while speaking about the diagnosis, where

the double lumbar incision showed me that the tuberculosis had proceeded from the completely destroyed left kidney, through the ureter, spread to the bladder, the mucous membrane of which was completely ulcerated, and from there had again ascended to the right ureter and there produced stricture and distention. In this case I performed extirpation of the left kidney and lumbar ureterostomy on the right side; by doing this I prevented the tuberculosis from ascending to the other kidney, which was still sound. I kept the fistula open until I had cured the bladder tuberculosis by carbolic treatment and dilated the ureter stricture. The passage through the ureter was then re-established, and the patient is still, six years after the operation, living and free from pains of the bladder, the right kidney officiating satisfactorily.

As a palliative operation I use and strongly recommend ureterostomy in cases of double-sided ascending kidney tuberculosis where stricture with distention of the ureter and pelvis causes great pain. In such cases we not only relieve the patient completely from pain, but, by establishing a free outlet, arrest the upward progress of the tuberculosis, and the patient's life is prolonged. Neither is it probably altogether out of the question that at an early stage an ascending kidney tuberculosis can be cured in this manner. Formerly I used a catheter or drain introduced into and fixed in the ureter, and which through the bandaging was carried to a concave-convex bottle which was tied to the lumbar region by a belt, but the frequent escape of the urine by the side of the catheter and the drawbacks resulting therefrom led me to construct a bandage consisting of a small silver capsula fitted with a rubber ring, and which, by means of an elastic girth round the abdomen, is kept tight round the ureter fistula, and from which a small silver tube through a drain leads the urine into a urinal.

I have already mentioned that the group of cases where tuberculosis is primary in the prostate and from there directly attacks the urinary organs, invading the urethra and the bladder, gives an exceedingly bad prognosis, on account of extrav-

asation of urine and the formation of abscess and fistula in the connective tissues of the pelvis. Yet in some cases it is possible to obtain partly curative, partly palliative, results through operative methods.

Where tuberculosis of the prostate has as yet only attacked the urethra, while the bladder is sound, I perform cystostomia suprapubica with insertion of a Pezzer catheter, and then extirpate the prostate, removing in connection with the latter the diseased portion of the urethra.

As a palliative, I have seen excellent results from cystostomia suprapubica in cases where a radical operation has no longer been possible.

TABLE OF CASES OF TUBERCULOSIS OF THE KIDNEY WITHOUT ALBUMINURIA.

No.	Name, age, occupation, date of admission and discharge	Concise previous history Obj. examination	Cystoscopy	Examination of the urine from			Operation	Course and Results	Remarks.
				the bladder	right kidney	left kidney			
1.	J. M. Male. 42 years old. Oct. 14, 1898. †Oct. 21, 1898. Private clinic	Well until 9 months previous. Frequent urination, cloudy urine. Treated at the "Kommunehospital" for pyelonephritis, later treated for chronic nephritis at St. Joseph's Hospital. Discharged Sept. 13, 1898, with *clear, albumin-free urine.* Very thin, miserable in appearance. *An enormous, fluctuating tumor is felt in the right side.* Frequent urination		Without albumin. Clear. *D.* 1000. *U.* 9.07.			Oct. 18, 1898. *Ether narcosis, Nefrectomia dextra. Enormous totally infiltrating tuberculosis of the kidney.* Ureter greatly inspissated, blocked with tuberculous, porridge-like substance. Miliary tuberculosis on the mucous membrane	Died of *myocarditis*	Treated elsewhere for Pyelo-nephritis and nephritis chorioidea, with the result that the urine became albumin-free.
2.	P.L. Male. 37 years old. June 2, '04 July 10, 1904. Private clinic	Well until 6 weeks previous. Then suddenly severe pains in the *left* side of the abdomen, out into the lumbar region and down toward the symphysis. Urination rather frequent and sharp. A little pus and albumin proved in the urine	Trabecular, small ulceration at the left ureter orifice, wherefore only the right one is catheterized. Clots of pus project from left ureter orifice	− Albumin − Tubercle bacilli − Microbes + Numerous Leucocytes D. 8.75 c.c. U. 11.2 Gm.	Urates. +Albumin +Erythrocytes. A few leucocytes		July 13, 1904. *Nefrectomia sin.* Kidney completely normal in size and shape, but firmly *attached* at the upper pole, where the palpating finger feels a group of miliary tubercles projecting from the surface. After splitting the extirpated kidney a focus, the size of a nut, was found in the upper pole. Ureter slightly inspissated	Quick, uncomplicated. Permanent recovery	Temporary Albuminuria. −Albumin. +Pus. −Microbes.

3.	Mrs. L. 30 years old. Fr. Hospital, Ward C. April 29 to July 3, 1908	4 partus. 3 children alive. Pt. always well until *5 years previously, when suddenly left-sided lumbar pains and hæmaturia appeared.* The hæmaturia disappeared after 4 days, but *the pains continued.* For eleven months she was in an infirmary, treated with morphia injections. Three following years without pains. Since then occasional attacks of heavy pains and hæmaturia. Admitted with diagnosis: *Stone in the kidney*	Normal, with the exception of a little œdema round left ureter orifice	−Albumin −Microbes +Leucocytes, not, however, with each examination	−Albumin −Microbes +Leucocytes. Röntgen	+Albumin (blood). +Erythrocytes. Röntgen	June 3, 1908. *Nefrectomia sin.* Kidney found somewhat enlarged and attached; from the convexity and back surface of the central third a whitish-yellow tumor, the size of a nut, projects. Lower pole somewhat rugged to the touch. Diagnosis vacillates between *syphilis* (gumma), *chronic nephritis*, and *tumor malignus* After cutting through the extirpated kidney the two upper and lower papillæ are seen to be the seat of destroying new-formations, and the tumor mentioned is whitish, pork-like, vague contours, with jelly-like black decay in the centre. Macroscopically the diagnosis vacillates between *carcinoma* and *gumma. Microscopy: Typical tuberculosis*	Recovery without complication.
4.	E. H. Girl. 9½ years old. May 26, 1911. July 19, 1911	The mother died of decline. Well until 1 month previous, when suddenly she had an attack of *severe hæmaturia* with vermiform coagulation. Since then frequent urination. No pains	Normal, without ulcerations	−Albumin −Leucocytes. −Cylinders −Bacteria −Tubercle bacilli	+Leucocytes	Normal	June 6, 1911. *Nefrectomia sinistr.* The kidney strongly adherent, red and injected. On the anterior two fluctuating portions (abscesses). Ureter inspissated. After cutting through the kidney a large abscess is seen in almost every pyramid. Miliary grains on the mucous membrane of the pelvis.	

TABLE OF CASES OF TUBERCULOSIS OF THE KIDNEY WITHOUT ALBUMINURIA.—*Continued.*

No.	Name, age, occupation, date of admission and discharge	Concise previous history Obj. examination	Cystoscopy	Examination of the urine from			Operation	Course and Results	Remarks.
				the bladder	right kidney	left kidney			
5.	F. Male. 21 years old. Jan. 22, 1912. Private clinic	The father died of decline. No venereal disease. In May, 1910, while a soldier, he got *hæmaturia* and pains with the urination. Healthy appearance. By exploratio rectalis the prostate is felt to be the seat of typical and large tuberculous protuberances	The ureter orifices normal, but in the left side half of fundus seeds of miliary tubercles and small typical ulcerations	−Albumin −Pus-cells −Tubercle bacilli	−Albumin +Pus-cells +Tubercle bacilli	−Albumin +Pus +Tubercle bacilli	Jan. 31, 1912. *Nefrectomia sinistr.* The kidney is found rather large, adherent upwards; an abscess is found in the upper pole. Here miliary tubercles are projecting from the surface. Mucous membrane of pelvis and calyx is oversown with miliary grains. Ureter inspissated like a string of beads	Tuberculosis in the lumbar wound. Development of bilateral tuberculous epididymitis. Epididymectomy.	
6.	J. O. Tailor. 30 years old. Jan. 4, '12. May 1, '12 Rigshospitalet	When 18 months old he got tuberculous left-sided coxitis and was operated on for this several times. Jan., 1905.—*Right-sided* tuberculous epididymitis with fistula formation. Urine normal. Castration at Frederiks Hospital, April, 1905. Well thereafter until Sept., 1911, when he got pains in the *right lumbar region*, which occurred in violent attacks. His doctor informs us that *albumin* has been proved in the urine at times; generally this is normal. *Left epididymis* is now attacked by tuberculosis. The Röntgen picture of the kidneys shows the left one to be normal, but the right kidney is enlarged, streaked, and spotted, no doubt originating from decay and accumulation	An *ulceration is found to the left of the right ureter orifice*	Jan. 6, '12 −Albumin −Blood, some leucocytes, a few erythrocytes. 1.5 Gr. urea −Tubercle bacilli Jan. 30.—Traces of albumin +Leucocytes, +Tubercle bacilli Feb. 8.— −Albumin	Jan. 30.— +albumin numerous leucocytes, −Tubercle bacilli	−Albumin	Jan. 10, 1905.—Castration. Jan. 16, 1912.—*Epididymektomia sinistra.* Feb. 28.—Ether narcosis. *Nefrectomia dextra.* The kidney is found *cystically degenerated;* toward the top the ureter is a little dilated and inspissated, but 7 cm. below pelvis there is a contraction, and the ureter then quickly becomes as thin as a silk thread. One imagines that the stricture may be tuberculous and the cystic degeneration a result of this, although it resembles the polycystic kidney. By cutting the removed kidney a triangular *urate-stone* is found in the orifice of the ureter and a whole heap of kidney gravel in the upper end of the pelvis. *Macroscopically* no signs of tuberculosis; *microscopically*, on the other hand, *miliary tubercles are found scattered* with *Langerhans'* gigantic cells. For the rest, chronic nephritis and cystic degeneration	Normal. Discharged completely cured with normal urine, May 1, 1912.	

7.	A. T. Farmer's wife. 23 years old. March 5, 1912	A normal partus 3½ years previously. Always in good health until 2 years ago, when she began to feel pains in *the left fossa iliaca, up under the left curvature and out towards the back*. Pains appeared *when patient walked about, but always vanished when she was lying down*. They appear in attacks, once—twice in the month at the beginning, now twice a week. She is tired and slack. *Urination normal*. Never hæmaturia or albuminuria. The kidney is not felt to be sunken. Uterus and adnexa normal	Slight œdematous tumor of the mucous membrane in *the left orifice of the ureter*, otherwise the bladder is quite normal	−Albumin −Blood does not gelatinate with numerous leucocytes. Gr. +Coccobacilli −Tubercle bacilli. Later on −Tubercle bacilli are found in the urine for the 24 hours	−Albumin −Leucocytes. −Erythrocytes. −Microbes	−Albumin +Leucocytes. +Erythrocytes. +Tubercle bacilli (a single bunch)	Mar. 29, 1912.—*Nefrectomia sinstra*. The kidney lies high, strongly adherent with the upper pole. Stern short so that the kidney cannot be drawn forth for inspection, wherefore one has to be contented with a very accurate *palpation*. In the upper pole one feels deep down an infiltrated portion, the size of a nut, and in a single place one feels miliary grains projecting under membrana propria. Otherwise the whole kidney appears normal in shape, consistency, and size, except just where the lowest pole turns into hilus, where a suspicious infiltration, the size of a pea, is felt. The ureter is not thicker than normally, but its wall seems somewhat infiltrated. After splitting the extirpated kidney a tuberculous infiltration, the size of a nut, is found round the upper calyx, which is the seat of a large tuberculous ulceration. Fine *striped* seed of miliary tubercles in corticalis. Corresponding with the pea-sized protuberance in the lowest pole, a fresh tuberculous infiltration of irregular shape is found without decay or ulceration, only a few miliary grains on the mucous membrane of the pelvis	Uncomplicated.

A CONSIDERATION OF GAS BACILLUS INFECTION WITH SPECIAL REFERENCE TO TREATMENT.*

A RÉSUMÉ OF THE LITERATURE AND A REPORT OF TWENTY-FIVE NEW CASES.

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In 1853 Maisonneuve [61] gave the first comprehensive description of the dread disease which we to-day know as gas bacillus infection, and ascribed to it the name of "gangrene foudroyante." A few years later, 1864, Pirogoff [62] described the same disease, calling it "primary mephitic gangrene." About the same time Salleron also wrote regarding this condition, and reported 65 cases which were observed during the Crimean War, but it was not until 1871 that its infective nature was demonstrated by Bottini.[63] In 1877 Pasteur [64] described a bacillus which he termed the "vibrion septique" and later Koch and Gaffky [65] found the same organism in the human body and gave it the name of "bacillus of malignant œdema."

Many cases of emphysematous gangrene were reported after this and ascribed to this etiological agent; in fact, even to-day many modern writers consider gas bacillus infection as due to the bacillus of malignant œdema in spite of the almost conclusive evidence that the infection is due to the *Bacillus aërogenes capsulatus,* which was first described and isolated from the blood of a human being by Welch,[60] in 1891. Fraenkel,[45] two years later, substantiated these findings, though working independently, and described a bacillus found in fatal phlegmons which he called *Bacillus phlegmonis emphysematosæ,* but which proved to be the same bacillus.

It seems that in this country at least the *Bacillus aërogenes capsulatus* is conceded to be the specific cause of gas infections,

* Read before the Bellevue Alumni Association, April 3, 1912.

the bacillus of malignant œdema not having been satisfactorily proven as able to produce gas in the human body, while various other organisms, at times credited as its cause, lack the necessary careful, cultural, laboratory data as proof. Welch believes that the production of gaseous gangrene in life, in the majority of cases, is due to the *Bacillus aërogenes capsulatus,* while Bloodgood says, "with symptoms of infection following trauma, the presence of large bacilli morphologically like the gas bacillus, even with the absence of gas bubbles or emphysema, is practically, in the majority of cases, pathognomonic of gas bacillus infection."

Many of the cases reported, ascribed either as due to the bacillus of malignant œdema or the *Bacillus aërogenes capsulatus,* have the same identical picture, however, and from a purely practical, clinical stand-point it would appear that it matters little which of these is considered the etiological agent; in fact in my paper I have included ten cases reported by Dussauze [6] due to the "vibrion septique" in which the signs are identical with those ascribed to the *Bacillus aërogenes capsulatus.* No doubt time will prove that both conditions are the same, since many of the authentic examples of each are characterized by three cardinal features, namely, gangrene, emphysema or gas in the tissues, and a wild type of infection.

To one acquainted with the literature on this formidable disease, the subject has a bewildering effect. Its astounding complicity of synonyms is staggering, and from its birth, in its steady climb up the hill of time, it seems to have accumulated added appellations until to-day one is prone to view it with despair on account of its ponderous and voluminous nomenclature, there being no fewer than eleven epithets applied to it.

It is a disease which appears to be little understood and infrequently recognized except in its advanced or final stages, a disease which is so insidious in its onset, so destructive in its steady progress, and so grasping upon the claims of life that it is viewed with dread by the surgeon and as a dire

calamity by the patient. Any disease which blots out five lives of every ten it attacks should certainly demand attention.

It is a disease about which to-day there seem much uncertainty and confusion. Most of the modern text-books treat it very superficially, some dismissing it with a few sentences, viewing it with extreme deference with respect to name, etiology, mortality, and treatment. One authority considers malignant œdema and *Bacillus aërogenes capsulatus* infection as one, while another in a 1912 edition, referring to this condition, says: "In traumatic gangrene of the extremities amputation at the highest possible point offers the only chance of saving the patient's life. Almost all the patients attacked by this affection die, and unfortunately even after amputation only 5 per cent. recover."

It is apparent from these preliminary remarks that the subject of gas bacillus infection is far from being well understood, and it seems to me that if anything, even of small import, can be added in clearing away this veil of incertitude and result in a more comprehensive understanding and elucidation of the subject, some justification at least exists for presenting these facts.

The acknowledged cause of gas bacillus infection, as suggested, is the *Bacillus aërogenes capsulatus,* a capsulated germ which belongs to the anaërobic group, a non-motile organism about the thickness of anthrax bacillus, with adjacent ends slightly rounded or square cut, and occurring in pairs, and at times in chains, staining by Gram's, and forming spores under certain conditions. It is normally found in the intestinal tract, having been observed in the appendix on two occasions. It has been recovered from the soil, cesspools, floor dust, and it would seem to be pretty generally distributed. There are two instances where infection has occurred in winter from injury by sleds where the ground was covered by snow at the time.

As regards the types of wounds in which this infection takes place, it may be briefly stated that it is most commonly found in wounds on which great trauma has been exercised,

as compound fractures, extensive lacerated wounds with pulpification of the tissues; in grinding accidents and crushes. There are on record two cases caused by gorings, one from a goat,[20] another from a deer[12]; three have resulted from bites of animals, several from obstetrical cases and operations around the perineum; a few from subcutaneous injections and one from tooth extraction.[10]

The mortality has been variously estimated. Welch[29] gave it as 59 per cent.; J. C. Stewart[23] at 55 per cent.; while Klotz,[5] in reporting 36 cases, estimated it as 50 per cent. Up to 1905 there were only 64 authentic cases on record and the general impression has been that it was a rare disease, but since then I have collected 123 others (including 10 of Dussauze,[6] which were not included in the first 64, but reported in 1902), bringing the grand total up to 187 cases. It is, however, a rare disease when compared to the number of injuries that actually occur, as in Bellevue Hospital during 1909 and 1911 there were 5802 cases of trauma, but only nine cases of gas bacillus infection, averaging 1 in 644.

The scope of this paper is threefold: first, to report 25 cases from Bellevue Hospital, eight of which have been treated in one definite manner, with no mortality; second, to review briefly all the cases published which are available and thus bring the subject up to date; to classify these cases if possible; to select from the list those which have been treated conservatively and compare this group with those upon which amputation has been practised; and third, to draw deductions from the information gathered, in order if possible to secure a broad comprehensive view regarding a definite treatment of this condition.

In preparing this paper I have carefully covered the histories of 187 cases. I have not been stimulated in its preparation by any desire to prove some certain fact, so that I have not been biased or prejudiced by my findings; in fact some of the ideas which I entertained beforehand have been rudely shattered by the evidence disclosed.

The 25 cases from Bellevue are those available since 1904,

or those occurring for the past eight years, and for the privilege of reporting the same I am extremely indebted to the visiting surgeons on the respective services, including Drs. Bryant, Stewart, Bissell, Hartwell, Hotchkiss, Woolsey, Smith, Lilienthal, Tilton, Gwyer, and Dennis. I have carefully excluded all those concerning which there was occasion for doubt, limiting myself to those which are typical of this infection as evidenced by characteristic signs or the actual isolation of the bacillus.

In this group of 25 cases, the *Bacillus aërogenes capsulatus* was found in 15 instances. In the other ten it was not sought. Twenty-four of these were confined originally to the extremities, one being the result of a craniotomy, which case is interesting from the fact that in the same room in which this was performed, a gas infection had been operated upon three weeks previously, and that at the time of the craniotomy a fly lit on the wound, which fact might possibly explain the source of contamination, as Walker, of Johns Hopkins, has isolated this bacillus from floor dust. There was a gross mortality of 44 per cent., there being 11 deaths and 14 recoveries.

With reference to the type of case: 10 were compound fractures; 10 were extensive lacerated wounds or crushes; 2 were due to gun-shot wounds; 2 were post-operative, and 1 followed a burn of the lower leg about which a blanket had been wrapped. On admission this patient was pulseless, the lower leg gangrenous, the skin brawny and of many colors, and gas in tissues from toes to breasts. She died within two hours after admission, permission to operate not having been obtained until shortly before death. The interesting point in this case was the fact that although this was a typical case of gas infection, no bacilli were found, the specimen having been obtained in the upper part of the thigh far remote from the original injury, which corresponds with Lahey's [28] findings that bacilli are very numerous in the vicinity of the original wound, but not present far distant, though the tissues there are macroscopically much diseased.

There were nine amputations in this group with six recov-

eries, or 66⅔ per cent. Eight of the 25 cases, of which five were of a very pronounced type, were treated by incisions and either a continuous irrigation or bath, with no deaths, and it is to this group of cases that I wish particularly to call attention. Five of the eight cases were personally known to me and were treated by free incisions and peroxide continuously administered locally; another, a post-operative one in the same service, apparently an incipient case, was treated by widely opening the wound and keeping it open and freely irrigating it, while the eighth, in the service of Dr. Hartwell, was treated by a continuous bath in bichloride.

In one of my cases amputation was performed eleven days after the original injury for a mixed streptococcus infection, after the gas bacillus infection had been eliminated. Three of these eight cases were of the superficial or incipient type, the others of a severe grade and of such a malignant character that in three instances amputation was advised and refused. The following résumé of the three will perhaps illustrate:

Case I.—Bellevue series, service of Dr. J. D. Bryant.

J. S., age twenty-six, male, was injured on December 19, 1910, in an explosion at the Grand Central Station by being struck in the lower third of the left thigh by a large, sharp rock which inflicted a long, ragged, lacerated wound of the skin and muscles and caused an indentation of the femur without fracture. Twelve hours after admission he complained of severe pain in the leg, and the temperature began to rise. The wound was dressed, but nothing abnormal found except a profuse bloody discharge. Twenty-four hours later the temperature had risen to 100.8°, pulse 136; there was emphysema in the tissues from below the knees to the costal margin, and gas was bubbling from the wound, from which also a foul odor was emanating. The muscles in the wound were greenish in color, the whole skin of the thigh of a mahogany hue and brawny to the touch. The patient himself looked septic. Amputation was refused.

Here indeed was a condition which seemed hopeless and each one who viewed it was emphatic in predicting a fatal outcome,

yet under a general anæsthetic, with good, deep, free incisions and drainage, followed by a continual application of peroxide of hydrogen, this patient made a slow but good recovery. At operation the muscles were greenish in color, well upon abdomen, gas was present everywhere, and the tissues juicy. A skin graft was later done and the patient left the hospital with a useful limb. No bandaging was employed, the limb lying naked in bed, covered only by a sheet. The *Bacillus aërogenes capsulatus* was found.

CASE II.—Bellevue series, service of Dr. J. D. Bryant.

L. L., a girl age ten years, was knocked down September 22, 1911, by a horse in such a manner as to cause a compound fracture of the right humerus with a lacerated wound one inch long at this site, as the arm came in contact with the curb. She was admitted to Bellevue and the wound dressed. She complained of pain 24 hours later and the wound was again dressed. Seventy-two hours after admission the whole arm was swollen, gas was bubbling from the original wound, crepitation was present in tissue of upper arm, and a foul odor was also evident. Temperature was 103°, pulse 104, respirations 24. Amputation was refused. Incisions were made in the upper arm, the wound freely opened, and dressed. Five hours later emphysema had extended to the chest; tissues gangrenous; there was gas both in the upper and lower arm and a second operation was performed, amputation being again refused. Free, deep incisions were made everywhere in the upper and lower arm, the axilla was opened widely and the pectoral muscles cut from their insertions to insure better exposure. The patient was afterward treated with continuous drip of peroxide without bandages and made a good recovery, except for extensive necrosis of the humerus. In this case a bacillus resembling *Bacillus aërogenes capsulatus* was found in the smear.

CASE III.—Bellevue series, service of Dr. Hotchkiss.

A. W., male, age thirty-three. Patient fell from a wagon to the pavement and was run over, sustaining a fracture of the right humerus and receiving a long, deep lacerated wound over the external and anterior aspects of the right lower leg, exposing the bone. The muscles were torn extensively, and much street dirt was ground into the wound. On the following day there was a profuse discharge from the wound; temperature was 102.4°, pulse 84. Two days later gas was escaping from the wound,

the tissues were gangrenous, emphysema extended from ankles to costal margin, the skin was brawny and of yellowish hue. Amputation was refused. The case was considered hopeless, but free incisions were made, one extending from the upper part of the thigh to the ankle, extending down to the bone on the outer side of the thigh. Gas escaped under pressure and the wounds gaped widely. Peroxide was used copiously for the next 24 hours and for 10 days the wounds were saturated every two hours with it. Skin graft later. Recovery.

In this case a smear was not made. This is the third instance of an apparently hopeless case which recovered by conservative methods, and would no doubt have been classed among those in which amputation was imperative had consent been obtained. The other five cases, of the same type but less extensive, are chronicled in their proper places at the end of this paper. The *Bacillus aërogenes* was found in four of these five; in the fifth it was not taken.

Impressed with these results, but still believing they were merely coincidences, I decided to review the whole literature, in order if possible to ascertain the experience of others. In my report I have carefully covered, as previously stated, 187 cases (1–22), including the Bellevue group, which résumé embraces all authentic cases on record known to me.

The majority of these cases were reported from this country, especially from its extreme eastern limits, but of late several cases have been reported from the West,[3] which would indicate that the soil of the East is not the only habitat of this germ, as was formerly suggested.

Over 84 per cent. of these cases, taken as an entity, involved the extremities, which from a surgical stand-point were favorably located. Seventy-six were due to compound fractures; 41 were the result of extensive lacerated wounds and crushes; 21 were post-operative; 15 had their origin in gunshot wounds; 8 were the result of subcutaneous injections of saline or from hypodermic administrations; 6 were either gynæcological or obstetrical; 6 were non-traumatic; 3 were due to bites of a lion,[8] horse,[6] and snake,[4] respectively, all of

which were of an extreme virulent character, one patient dying within 30 hours after the receipt of injury; 2 were due to gorings by animals and the remaining 5 were unclassified. In 2 cases, infection seems to have originated in the wards of the hospital, one (Bellevue group) occurring 13 days after the primary injury, the other [20] 14 days later.

For the 187 cases the gross mortality was 48 per cent. There were in all 50 amputations (barring Klotz's 36 cases concerning which no mention of treatment is made), with 18 deaths and 32 recoveries, a mortality of 30 per cent. from this form of operation. In contrast to this mortality of 36 per cent. for amputation, there were 30 cases involving the extremities, treated conservatively by incisions followed by continuous or frequent irrigations or baths, with three deaths, and all three due to complications; one from tetanus,[6] one from secondary hemorrhage,[6] and one of Bloodgood's [43] from a mixed infection 25 days after injury. In each case the gas infection was fully under control some days before death occurred. Nor can I find a single instance, where generous incisions were made at the outset and the wound continuously irrigated or placed in a bath, that death has taken place. Three of these 30 cases were amputated at some period in their convalescence on account of destructive effects of the disease, but not to control it.

There were nine other cases also treated in this conservative manner where the infection was located upon the trunk; all but one were superficial and all but this one, which was a deep infection in the gluteal region, recovered. Nor am I able to find here a single instance of death where the infection has been limited to the tissues external to the deep fascia, which seems extremely resistant, no matter what form of treatment was employed; two of the cases having been treated simply by incisions, the wounds having been left open. Four of these were due to the injection of salt solution subcutaneously, the infection probably occurring from the salt employed in making the solution, as C. C. Barrows of New York has recently found the bacilli in the salt used in a case

of an intravenous infusion followed by gas infection, which resulted fatally.

It will no doubt be argued by some that these were mild infections, local in extent and recognized early, where amputation would not have been employed anyway. But it seems this is far from the real facts, for many of these cases were similar to those I related from the Bellevue series, and of a high grade of infection, well advanced and extremely extensive, in which, in some instances, amputation had been refused and in others a more radical operative procedure was thought to prove fatal, as exemplified in the cases described by Mann,[40] Bloodgood,[43] Welch,[4] Dussauze,[6] Loving,[12] and others.

There were eight cases where amputation had taken place below the limits of infection through diseased tissues or the stump reinfected, and recovery in every one resulted where the wound was opened widely, incisions made, and irrigations instituted, except in one instance complicated by tetanus.

From the foregoing facts and compilations, coupled with case histories which follow, it would seem that there are many valuable deductions to be made. In the first place it appears that when gas infection is once well established, its progress is rapid, destructive, and certain to result in death without treatment. It appears also that those cases described as mild are either those in the incipient stage, where the case is discovered early, or those cases superficial to the deep fascia.

In 15 of the 25 cases reported from Bellevue and in many of the others, pain out of all proportion to the trauma, coming on 12–36 hours after injury, was the first sign of trouble, and this was soon followed by a sudden rise in temperature. These manifestations seem to be the forerunner of this condition.

Pus is seldom present, but any wound resulting from traumatism with a gangrenous appearance, coupled with a sudden rise in temperature and pain, even without the presence of gas in the wound or emphysema in the tissues, should excite suspicion and a smear should be taken immediately, as Bloodgood [43] has reported two cases in which no gas was

present but which were due to *Bacillus aërogenes capsulatus.*

It is very evident in reviewing the literature that few cases are recognized early, the majority being well advanced before operative means are employed, which fact is no doubt one of the reasons for its high mortality. Its incubation has been variously estimated from 24 to 48 hours, which period seems, though, to have been reckoned from the time of injury to the time the case was first seen rather than to the time of the first manifestation, and no doubt the incubation is very short, as cases have been reported coming on 8, 12, and 16 hours respectively after injury. It is also apparent that in those cases in which the disease is early recognized its progress is easily controlled by proper treatment.

In the consideration of treatment itself, it seems evident that in view of the foregoing statistics we should stop and inquire if we have not been too radical in our endeavors, and if conservatism should not rather be employed in order to avoid the baneful results and crippling deformities of an amputation. Is it not better surgery and do we not owe it to the patients to save a limb when such a low mortality is possible with less radical measures?

Prophylaxis is probably the most important aspect of treatment. All wounds on which great force has been exerted, and especially those contaminated by soil and dirt-covered objects, should be treated as if infected with gas bacilli. They should be left open where possible and thoroughly irrigated with peroxide. They should be lightly bandaged, and where possible even this should be discarded. They should be inspected frequently and frequently irrigated, and never incased in plaster.

On the first sign or symptom of infection, a smear should be taken and examined. The wound should be freely opened if sutured, and if on the extremities, where most of these infections occur, the limb should be placed in a bath or continuously irrigated. If the condition is extensive, free incisions should be placed and the whole field widely exposed to air. No bandaging which excludes air should be employed,

the limb being simply covered by a sheet or suspended in a tent.

There seems to be little reason to doubt that the causative agent being of an anaërobic variety, oxygen in some form should be employed, either in the form of air, oxygen gas, hydrogen peroxide, or water, although Lahey[28] has proven experimentally that under certain laboratory conditions the bacillus will live at least 24 hours aërobically. All forms of air have been employed with good results, but peroxide or oxygen itself seems to eliminate the infection more quickly than water. Peroxide, however, should never be employed in full strength and should never be used in confined spaces or injected directly into the tissues, as it has caused immediate death in animals when employed thus.[28]

As regards amputation, which it seems should be resorted to rarely if the best results are to be obtained, spinal anæsthesia should be employed, since these patients are as a rule septic and in no condition to withstand a general anæsthetic. Even for extensive multiple incisions where anæsthesia is not present from the infection itself, it seems to me spinal anæsthesia is indicated. In one of the cases treated personally, in which amputation was resorted to nine days after the gas infection was controlled, for mixed infection, spinal anæsthesia was employed on two different occasions, and I feel positive that if the patient had been subjected to general narcosis, the result would have proved fatal.

In conclusion there are several facts which stand out prominently:

1. That the incubation is very short.

2. That the disease can be classified into superficial and deep. The former is easily combated; the latter requiring prompt and energetic action.

3. That more conservative methods should be employed in the treatment of gas bacillus infection.

4. That oxygen in some form should be used, preferably in the form of hydrogen peroxide.

5. That extreme pain coming on during the first 24 hours

following a severe injury, and this accompanied by a sudden rise in temperature, may be the first symptom of gas bacillus infection.

6. That early recognition is the keynote in combating this condition.

7. That smears should be made from the original wound and not from some point distant to it.

CONTINUATION OF REPORTS IN BELLEVUE SERIES.

CASE IV.—J. O., male, admitted December 4, 1910, service of Dr. Bryant.

On the night of admission he fell down an open elevator shaft (distance unknown), striking his foot against the roof of the elevator in such a manner as to receive a deep lacerated wound on the inner aspect of the ankle and a compound fracture of the tibia which involved the ankle-joint. On the following day the temperature was 102°, pulse 80, respirations 20. The tissues in and about the wound were gangrenous, emitting a foul odor, and gas was bubbling from the wound, but no emphysema in the tissues. *Bacillus aërogenes capsulatus* found. Free incisions were made, drainage employed, and a continuous peroxide drip begun and continued two days, followed by a chinosol bath. In 36 hours there was no gas present, odor had disappeared, but a streptococcus infection ensued. Amputation was performed eleven days after admission, below the knee. Spinal anæsthesia. Four days later, under spinal anæsthesia, amputation at thigh. Recovery.

CASE V.—J. W., male, admitted November 12, 1908, service of Dr. Bryant.

On November 6 the patient struck his hand against the teeth of a second party during an altercation, inflicting a wound over the knuckle. The following day his hand became swollen and painful and was dressed by a physician. On November 12 he came to the hospital, where it was found that he had a lacerated wound over the first metacarpophalangeal articulation which was infected. Incisions were made, drainage instituted, and the hand dressed daily. On the evening of November 18 the patient complained of pain and could not sleep. The next day, on dressing the wound, gas was bubbling from the wound and the tissues

were gangrenous in and about the edges of it. The temperature was 102.8°, pulse 120, respirations 28. The hand was placed in a bowl of hydrogen peroxide, and in 24 hours the condition subsided, no gas was present and the temperature had fallen. A smear showed a capsulated bacillus.

The infection here seems to have been picked up in the ward. It was apparently in the incipient stage and recognized early.

CASE VI.—Henry R., age twenty-two, admitted March 20, 1909, service of Dr. Stewart.

On the day previous to admission, he was shot by a .38-calibre pistol, the bullet entering about the middle of the right leg just external to the crest of the tibia and ranging downward and backward. The bullet was extracted by a drug-clerk who made an incision posteriorly. The patient slept on a truck all night and came to Bellevue the next afternoon, suffering from pain in the leg, with temperature of 101.5°, pulse 100, respirations 24, on which occasion there was gangrene around the margin of the wound and emphysema was present in the whole lower leg. He was shown in Dr. Stewart's clinic as a case of gas bacillus infection. Under gas anæsthesia the leg was freely incised, the primary wound enlarged. Peroxide drip was begun after wounds had been thoroughly irrigated with it. In 24 hours there was no gas in the tissues and no extension.

This was no doubt a beginning infection which was recognized early. The *Bacillus aërogenes capsulatus* was not sought. Recovery.

CASE VII.—J. Z., age eight, admitted February 20, 1909, service of Dr. Hartwell.

Patient was knocked down by a team of horses, the rear wheel of the heavy truck to which they were attached passing over his left foot, which was extensively mangled and bled profusely. On the dorsum of the foot was a deep lacerated wound, extending from the external malleolus to the great toe; a traumatic amputation of the great toe and a compound fracture of the fourth metatarsal. On admission the foot was cleaned up under anæsthesia and a portion of the first metatarsal removed. On the following day the temperature was 102°, pulse 146, respirations 28, the patient was complaining of great pain in his foot, and was vomiting. Forty-eight hours later gas was discovered in the tissues, a foul odor was present, and the third toe gangrenous. The third

toe was removed. Incisions were made on the dorsum and the original wound opened widely. The foot was placed in 1 : 5000 bichloride bath for 15 minutes every two hours for the following seven days. Recovery. *Bacillus aërogenes* found.

CASE VIII.—Male, age twelve. Bellevue Hospital series. Personal communication from Dr. Hotchkiss. It was a post-operative case from plating of femur following a compound fracture. Two days following the operation, gas was discovered in the tissues with a gangrenous condition in the wound from which gas bubbles emanated. The wound was opened widely, treated with peroxide. Recovery.

This was evidently an incipient case and early recognized, which subsided quickly after prompt treatment. No smear made.

The above cases are those treated by the open method plus incisions. One was amputated, but for a mixed infection.

The following comprise the remaining cases in my report which were treated otherwise:

CASE IX.—C. E., boy, age twelve, admitted October 8, 1906, service of Dr. Bryant.

On the day previous to admission the boy fell from a tree, a distance of 25 feet, striking the ground in such a manner as to receive a compound fracture of both bones of the forearm, which bled freely. Temperature on admission 103°, pulse 120, respirations 24. On the following morning the forearm and hand were much swollen and of a bronze color. No crepitus. Chinosol bath. In the afternoon of the same day, crepitus was well marked in the forearm. Multiple incisions. By night crepitus had extended above the elbow. Arm amputation at upper third. Flaps left open. Stump irrigated with peroxide. Recovery. A large capsulated bacillus found.

CASE X.—P. B., male, age twenty-six, admitted September 25, 1907. From Second Division, Bellevue.

Patient, while intoxicated, was knocked down by a trolley car, both wheels of forward truck passing over left leg, terribly mangling the foot and lower leg. Two days later, patient had severe pain, the toes were gangrenous, the tissues crepitated, and an odor of decaying flesh was apparent. Amputation below knee. Temperature 102.8°, pulse 124, respirations 28. Recovery. *Bacillus aërogenes capsulatus* present.

CASE XI.—J. H., male, age sixty-five, admitted April 18, 1909, service of Dr. Tilton.

Patient, a driver, was knocked from his truck in such a manner that his leg was caught in the whippletree and he was thrown to the ground, receiving a compound fracture of both bones of the leg, the fragments of bone appearing in the wound, which was a lacerated one about five inches long. The wounds were irrigated, fracture reduced. Two days later the temperature was 104°, pulse 102, respirations 22, gas present in the tissues, foul odor. Amputation at thigh. Recovery. *Bacillus aërogenes capsulatus* found.

CASE XII.—Edward C., age twenty-one, admitted June 7, 1907, service of Dr. Gwyer.

On the day of admission the patient was knocked down by a trolley car and dragged 50 feet, sustaining a large lacerated wound over the right knee, opening into the knee-joint. On the following day he complained of severe pain, and on dressing the wound gas was seen bubbling from the wound, odor foul. Temperature 102°, pulse 72. Leucocytosis 21,000, polynuclears 75 per cent. On June 14 the knee was opened by an incision across the patella. June 15 amputation through thigh. Recovery. *Bacillus aërogenes capsulatus* found.

CASE XIII.—P. N., age thirty-two, male, admitted June 16, 1910, service of Dr. Smith.

Patient, while under influence of alcohol, caught left foot in a trolley car wheel, receiving a lacerated wound on the sole of the foot which bared the tarsal bones, also a deep wound on the dorsal surface of the foot, from which bones were protruding. Both wounds were contaminated with street dirt and bled profusely. Patient complained of severe pain 24 hours later. Forty-eight hours after admission gas was present in the tissues, gangrenous condition of wound, odor foul. Temperature was 104°, pulse 120, respirations 28. Amputation. Stormy convalescence. Recovery. Bacillus not sought.

CASE XIV.—A. A., age twenty-five, male, admitted February 2, 1909, service of Dr. Hartwell.

Patient was knocked down by a car, one day previous to admission, receiving a lacerated wound about three inches long over the dorsal surface of the foot, exposing tendons and ligaments. On admission, 24 hours after accident, he was suffering

severe pain. Temperature 101°, pulse 104. Three days later there was gas in the tissues around the wound, foot swollen, foul odor, tissues gangrenous. Amputation below knee. Recovery. *Bacillus aërogenes capsulatus* found.

CASE XV.—L. Z., female, age thirty, admitted September 13, 1906, service of Dr. Bryant.

Patient while cleaning windows fell from the third story, receiving a compound fracture of the right forearm and fractured tibia. Twelve hours after the accident she complained of severe pain. Forty-eight hours after injury the right arm was greatly swollen, gas in tissues of whole arm. Temperature 103°, pulse 124, respirations 40. Multiple incisions. Death. *Bacillus aërogenes capsulatus* found.

CASE XVI.—S. N., male, age forty-two, admitted December 24, 1909, service of Dr. Walker.

Twenty-four hours previous to admission, patient's right arm was caught in a macaroni machine, sustaining a long lacerated wound anteriorly over the arm, extending from the shoulder to one inch below the elbow, and another posteriorly over the shoulder. Wounds sutured and drained. On admission he complained of pain in the arm. Temperature was 104°, pulse 120, respirations 28. Odor from the wounds foul, arm swollen, and emphysema in the upper arm and shoulder. Complained of feeling chilly. Palpation not painful. Stitches removed, dressed with formalin, bichloride, peroxide, bandage. Death. Organism not sought.

CASE XVII.—F. De, male, age twenty, admitted September 18, 1911, service of Dr. Lilienthal.

Patient operated upon for glioma of brain. Four days later gas in the wound and scalp, foul odor. Death. *Bacillus aërogenes* found. A fly lit upon the wound during the operation, which was done in a room in which Case II had been operated upon. A possible source of contamination.

CASE XVIII.—J. O., male, age forty, admitted December 31, 1909.

Patient was knocked down by a car and dragged under it. Taken to hospital unconscious, with comminuted fracture of tibia, over which was a lacerated wound, five inches long, which involved skin and muscle. Twelve hours later he complained of severe pain in leg. On the following day there was gas in the

tissues of the leg and gangrene of the foot. Temperature 104°, pulse 132, respirations 22. Amputation at thigh. Death. Bacillus not sought.

CASE XIX.—A. R., male, age thirty, admitted March 4, 1906, service of Dr. Gwyer.

On the day previous to admission right leg was caught in a cog-wheel of a machine. Received a compound comminuted fracture of the tibia, several pieces of the bone protruding from the wound. On the following day the patient complained of severe pain, gas was bubbling from the wound, with a foul odor, a crepitation in tissue of the leg. Temperature 102°, pulse 120. Drainage, carbolic dressings. Amputation at lower thigh. Death. Bacillus not sought.

CASE XX.—P. P., male, age forty-three, admitted September 13, 1906, service of Dr. Bryant.

On the day of admission, patient's left leg was caught between the pole of a wagon and a street car, sustaining a compound fracture of the femur, the wound in the tissues being extensive, deep, and lacerated, the biceps muscle being torn across. On the following day pain was severe, and on dressing the wound, gas in wound, tissues gangrenous, foul odor. Temperature 104°, pulse 128, respirations 32. Incisions, drainage. Death. *Bacillus aërogenes* present.

CASE XXI.—R. S., age fifty-seven, admitted December, 1906, Second Division.

While walking along the street, patient hit in knee by a bullet which entered the joint. Twelve hours later severe pain. Thirty-six hours later, temperature 104°, pulse 118, respirations 34. Foul discharge from wound and bubbles of gas expelled. Vomiting. Death. *Bacillus aërogenes capsulatus* found in wound.

CASE XXII.—J. B., boy, age thirteen, admitted October 20, 1906, service of Dr. Dennis.

On day of admission he was knocked down by a train and dragged along the ground for some distance, sustaining a deep lacerated wound, extending from the gluteal region to the popliteal space. On the following day crepitation in tissues about wound. Temperature 104°, pulse 160, respirations 28. Three days later crepitation to abdomen anteriorly. Death. Bacillus not sought.

CASE XXIII.—P. A., male, age thirty-five, admitted April 11, 1907, Second Division.

Patient's left foot was run over by a railroad train, crushing the foot. Two days later foot was gangrenous over injured area, odor foul, crepitation in foot. Temperature 103°, pulse 120, respirations 20. Crepitation extended. Amputation of foot. Wound infected. Crepitation extended to thigh. Death. *Bacillus aërogenes capsulatus* found.

CASE XXIV.—G. P., girl, age fourteen, admitted November 22, 1904, service of Dr. Bryant.

On day of admission she fell two stories, striking on both hands and sustaining a lacerated wound over ulnar side of left wrist, through which ulna was protruding, covered with dirt; radius also broken. Colles's fracture on opposite side. Lacerated scalp wound. Fractures reduced, drained, plaster splint. On following day severe pain, temperature 104°, pulse 110, respirations 24. Multiple incisions, wet carbolic dressing. Two days later left arm to one inch below elbow black, œdematous, with crepitation and foul odor. Extension. Death. Bacillus not sought.

CASE XXV.—V. P., female, age fifty-three, admitted January 11, 1912, service of Dr. Stewart.

Three days previous to admission patient suffered a stroke of apoplexy, resulting in paralysis of right arm and leg. She complained of feeling cold in her leg, and water bottles were applied, which caused a burn midway between the ankle and knee. Around this burn a blanket had been wrapped. On the following day the leg became blue and swollen. This condition extended, and on the following day she came to the hospital with a temperature of 102°, pulse 138, respirations 42. The right foot was gangrenous, the toes white, the whole leg to groin was mottled, of a brownish-bluish tint, brawny to the touch. Crepitation was present from the ankle to breasts and seemed under great tension. A tympanitic sound could be elicited on percussion. By the time permission to operate was obtained she was pulseless and died within an hour.

Although this was a typical case, a specimen taken from the upper third of the thigh proved negative, which fact supports Lahey's experiments.

Cases Treated Without Amputation.—Loeb, 1; Mann, 1; J. C. Stewart, 1; Bloodgood, 6; Dobbin, 1; Dussauze, 9; Blake and Lahey, 4; White, 2; Loving, 2; Hotchkiss, 1; Clark, 1; Eagleton, 1; Hoseman, 1; Bellevue cases, 8.

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MEDIASTINAL AND PERICARDIAL INFECTIONS IN RELATION TO EMERGENCY ABDOMINAL SURGERY.

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THERE is nothing more interesting or important in medicine or surgery than the early and correct diagnosis of the abdominal emergencies. In no other cases is prompt surgical interference so important as a life-saving measure. Acute appendicitis, cholecystitis, visceral perforation with beginning general peritonitis are emergencies the magnitude of which cannot be exaggerated.

Within recent years it has been shown, notably by Brewer and myself, that acute focal suppurative nephritis, or infection of the cortical vessels of the kidney through the blood, can simulate exactly these intraperitoneal emergencies. In this paper for the first time attention will be called to the fact that certain mixed conditions in the mediastinum and pericardium also can do this, and are therefore of importance in relation to the diagnosis of acute abdominal infections.

Chronic inflammation in the mediastinum resulting in the formation of strong adhesions, involving the diaphragm, pleuræ, and other structures, is known to cause an abdominal symptom complex of a chronic type, with enlarged liver, recurrent ascites, constipation and diarrhœa, emaciation, and death; in some cases pleural effusions are present also. This may be due to tuberculosis or to a low grade septic infection. In these chronic cases the clinical picture is caused in the main by obstruction of the venous and lymphatic circulation because of the dense matting together of the mediastinal tissues. It is important to know that in the earlier stages of these chronic cases, before obstruction is marked and before

any suspicion of the pathologic condition is aroused, an acute septic pericarditis may supervene, and that such cases can exactly simulate duodenal or gastric perforation; that is to say, that the engrafting of an acute serous or seropurulent pericarditis upon a chronic obliterative mediastinitis, which has already caused some obstruction to the venous circulation of the liver, can give an acute abdominal picture exactly similar to visceral perforation high up in the peritoneal cavity.

It has been noted by a few observers, especially by Babcock, that rarely an acute serous or seropurulent pericarditis may occur in the case of a chronic obliterative mediastinitis, but no observer to my knowledge has even called attention to the importance of this mixed condition in the mediastinum in relation to abdominal surgical diagnosis. I have been able to find no discussion of the subject from a surgical standpoint. Fortunately, the condition as a cause of mistaken diagnosis in abdominal surgery must be very rare, but since it can occur, as is illustrated by my case reported later in this paper, it should be considered as a possible cause of error. Whether it can be diagnosed correctly before operation is problematical. It may be said that, if cases like this are so rare and the chances of error so very small, this paper can have no or at most very slight practical value, but I do not see how its clinical and pathological features can fail to be interesting and instructive.

It has long been known that an acute pericarditis with effusion is a disease that is frequently overlooked. The most common symptom is pain referred to the epigastrium. A low grade chronic infection in the mediastinum with adhesions and gradual obstruction of the venous returns through the liver cannot be diagnosed early in its course, yet during this time there is an increasing passive congestion and enlargement of the liver with stretching of the capsule, and in certain cases more or less perihepatitis. The effect of an acute coincident infection upon the chronic obliterative process in regard to symptoms will be considered in detail later.

Chronic mediastinopericarditis was described first by Kussmaul in 1873. Harris, of Manchester, England, in 1894, published a valuable article in which he collected all the reported cases to that date. Pick gave this condition the name of pericarditic pseudocirrhosis of the liver. Kelley recently, in an exhaustive article in which the possibility of infection through the peritoneum is suggested, calls the condition multiple serositis. This pathological condition is one of more or less extensive hyperplasia of the fibrous tissues of the mediastinum binding together the structures therein, often associated with adhesions between the two layers of the pericardium. Fibrous adhesions bind the heart sac firmly to the diaphragm, to the anterior chest wall or both, to the pleuræ, œsophagus, and spinal column. In certain cases all the contents of the mediastinum are so matted together by fibrous tissue that they cannot be separated without mutilation of the organ.

In a few of these cases in the late stages, when ascites has become the dominant feature, an operation has been done under a diagnosis of portal cirrhosis. The disease occurs most frequently in children and young adults; it is most frequent in males. A typical chronic case of this sort was under my observation at the Massachusetts General Hospital, and formed the basis of a medical thesis on the subject in the year 1893.

Case of E. H., East Medical Records, volume 447, page 108, February 2, 1893. Boy 18 years old who went into the hospital when the abdominal distention due to ascitic fluid was extreme. His most troublesome symptom was dry cough and dyspnœa. He lived nearly two months after entering the hospital.

At the autopsy typical obliterative mediastinal pericarditis was found.

The history of this case has been given in detail in an article by Dr. R. C. Cabot, published in 1898. Cases similar to this have been reported by James Bennion and by G. A. Gibson.

The cause of this chronic condition was thought to be, in the majority of cases, extension of a chronic pericarditis through the external layer of the pericardium, so Babcock's alternative term for chronic mediastinopericarditis is chronic pericarditis externa et interna. Very recently students of the

subject, correctly I think, have come to feel that the majority of these cases start as a mediastinal infection and that the involvement of the pericardium is a later condition, that in most of the cases the infection starts in the mediastinum from the bronchial or mediastinal glands, the infection being either tuberculosis, as it undoubtedly is in most cases, or a low grade septic infection from the lungs, pleuræ, or blood. One other source of infection that in a measure may serve to explain the multiple peritoneal and pleuritic adhesions in the advanced cases is the peritoneal cavity, since the chief drainage channels of the peritoneal cavity are through the diaphragm into the mediastinal glands.

I think I am presenting a new thought in the differential diagnosis of abdominal infection. The following case is the basis for this paper and its conclusions:

Report of Case.—H. S., a Jewish boy aged eleven, who had never had any previous illness or spent a sick day in bed, a patient of Dr. J. S. Morris, of Revere, Mass., was first seen by me at noon on September 1, 1910. Ten days before I saw him, after spending a long time in the salt water, the boy was taken with a mild febrile attack which resembled an acute coryza, with the exception that he complained of a little pain at the apex of the left lung on deep inspiration. Examination of this area by Dr. Morris found nothing but a few slight friction rubs which disappeared within 24 hours. The boy's temperature in this attack did not go above 100.5° F. and became normal at the end of the third day, when he apparently was as well as usual, up and playing out of doors. (Note the slight attack, apparently a cold, from which he seemed to have recovered.) Three days after apparent recovery and five days before he was first seen by me, after eating heartily of apples, ice cream, etc., he had a sudden attack of epigastric and abdominal pain, which made him cry out and writhe about on the floor. He vomited several times in this attack. Temperature was 100° F., but nothing abnormal could be found on physical examination according to Dr. Morris. He recovered in a few hours and was apparently as well as ever. Two days before I saw him he had some nausea and vomiting, and complained of abdominal

pain. The day before I saw him he had no fever, no pain, and was up and about. On the morning of September 1 he was suddenly taken with another attack of intense abdominal pain and tenderness, especially in the epigastrium and right hypochondrium, well down into the flank, and vomited several times. I saw the boy then for the first time, about three hours after the beginning of the attack. He was well nourished and developed, apparently very sick, with a rapid and irregular pulse. In the epigastrium and in the right and left hypochondrium were exquisite tenderness, muscle spasm, and well-marked dulness. Because of the extreme tenderness and muscular rigidity no definite mass could be made out, but because of dulness a mass or collection of fluid was considered. His temperature was 101° F., respiration 40, face pinched and anxious, leucocytosis 20,000. Careful examination of the chest found nothing abnormal except respiration in the left back was somewhat shallow, apparently due to the tenseness in which the abdominal muscles were held because of pain. Heart was normal in situation and size. I could find no evidence of fluid in the chest or abdomen. The picture was a typical one of spreading peritonitis following infection high up in the peritoneal cavity. The previous history favored this diagnosis.

The boy was removed to the Frost Hospital, Chelsea, and operated upon within an hour in the presence of several of the hospital staff. Never have I felt more confident of the correctness of my diagnosis nor have I ever felt more surprised at what I found.

Upon opening the abdomen in the median line above the umbilicus I came down upon a very large and very much congested liver. The organ was displaced a hand's breadth below the margin of the ribs. It was also enlarged to the left, so much so that the notch between the lobes was well to the left of the median line. There were no adhesions made out at the time of the operation between the liver, abdominal wall, and diaphragm. (In this connection please note the finding of fairly extensive adhesions at the autopsy.) A small amount of bloody fluid was found above the large lobe of the liver, cultures from which proved to be sterile. The intestines and stomach were everywhere pale and collapsed. There was no evidence of intraperitoneal infection. The spleen and kidneys were normal in

size and position. Although the boy was in bad condition, sufficient time was taken to explore the abdomen thoroughly.

Findings at the operation were negative except for a very large, markedly congested liver, with a small amount of bloody, ascitic fluid between the liver and diaphragm.

The night after the operation the temperature rose to 103° F., but came down to normal on the third day, where it remained until his death. The leucocyte count diminished, and stained slides of blood showed nothing important. The urine for one day showed a suspicion of bile, but at other times was negative. The boy lived two weeks. On the third day after the operation he had no fever and was comparatively comfortable so far as acute pain was concerned, although tenderness and dulness in the upper abdomen persisted. Forty-eight hours before death he became increasingly cyanosed, and signs of fluid in the abdominal cavity and chest were found. Twelve hours before death he was seen by me and by my assistant, I not having seen him for four days previously. At this time there was evidence of a large amount of fluid in the chest and some in the abdominal cavity. I did not suspect at this time pericardial fluid, but did make out extensive intrapleural effusion on both sides. There was marked cyanosis of the face and body, and feeble and irregular pulse and rapid respiration. The heart sounds were heard indistinctly and the organ was evidently somewhat displaced to the right. The left pleural cavity was aspirated and a large amount of bloody fluid drawn, as much as the condition of the boy permitted at this time.

Report of Autopsy (at the Frost Hospital twelve hours after death).—A boy about eleven years of age, well developed and nourished; no glands felt; abdomen distended, walls tense. Head not examined. Small amount of subcutaneous fat. Muscles normal. Peritoneum smooth and shining. Intestines distended. Appendix not remarkable. Small amount of pale, clear fluid in the peritoneal cavity. Liver adherent anteriorly to the abdominal wall above and posteriorly to the diaphragm in the median line. The anterior margin of the lobes of the liver was a hand's breadth below the costal margin in the mammillary line on each side. Diaphragm on the right side, seventh rib; on the left side, eighth rib. The right pleural cavity was filled with a large amount of clear fluid; the left pleural cavity was filled with a large amount of bloody fluid. The pericardium was firmly adherent to the anterior chest wall, to the lungs on either side, and to the diaphragm below. These adhesions were strong and of long standing. The pericardium was distended with fluid.

Upon opening the pericardium it was found to be 5 mm. thick and to contain much bloody fluid with considerable gray, soft fibrin, free and attached to the pericardium and heart. The heart weighed 215 Gm. Pericardium much thickened and in one place there was a large mass which was raised .75 cm. above the heart wall and was 2 cm. in diameter at the base and 1 cm. at the apex. The parietal pericardium was firmly adherent to the heart wall below the roots of the great vessel. The myocardium was firm and of good color, the left ventricle wall being 10 mm. thick, the right, 3 mm. The cavities were slightly enlarged. The chordæ tendinæ were well marked. The heart showed some hypertrophy and dilatation. The valves were normal and there was no evidence of endocarditis. The coronary arteries were free. The mediastinal space was filled with dense fibrous adhesions of long standing, binding all the structures firmly together. The bronchial lymphatic glands were enlarged and showed some signs of inflammation but no evidence of tuberculosis. Both lungs were pushed upward by the fluid in the pericardium and pleuræ; they were sound at the apex and, aside from some chronic passive congestion, were normal.

The aorta and great vessels and œsophagus were normal. The stomach and duodenum showed some congestion. Intestines not remarkable. Liver weighed 1022 Gm. and showed typical passive congestion with hypertrophy. There were no stones in the gall-bladder and the bile-ducts were free. Pancreas not remarkable and the duct of Wirsung free. Spleen weighed 72 Gm., small, and the trabeculæ and follicles were visible. There was an accessory spleen 1 cm. in diameter. There was some passive congestion of the kidneys, which were otherwise normal. The mesenteric and retroperitoneal glands were not remarkable. Examination for bacteria showed by the Gram stain from the pericardial fluid some single cocci, a few diplococci, and also several bacilli. Cultures from the peritoneal fluid at operation and from the chest fluid aspirated were sterile.

Anatomical Diagnosis.—Acute serofibrinous pericarditis; hypertrophy and dilatation of the heart; chronic passive congestion of the liver; chronic perihepatitis; chronic mediastinitis.

At the close of the operation, in discussing the case, I said that I could imagine no cause for the symptoms except some obstruction in the mediastinum, inflammatory or malignant, which had progressed sufficiently far to cause intense passive congestion of the liver, and that the pain might be due to stretching of its capsule. The associated fever, leucocytosis, etc., I could not explain then, thinking at the time of mediastinal obstruction, but not of pericarditis also.

In analyzing the above case it is important to remember that in childhood acute infections above the diaphragm may

cause misleading abdominal symptoms and signs. A right-sided pneumonia has been diagnosed and operated on more than once as appendicitis.

Epigastric pain at all ages is not an uncommon symptom in acute pericarditis and one appearing early in the course of the disease before friction rubs or signs of fluid appear; but pericarditis alone could not have caused such intense pain, so widely distributed and with such a large area of extreme tenderness and dulness as in the case reported.

It is known that passive hyperæmia of the liver with hypertrophy can be the cause of pain and some tenderness on pressure in the epigastrium and hypochondrium, but the pain from such a pathologic condition is subacute, and the tenderness is not extreme and often absent.

The enlargement of the liver in passive congestion, obviously, is a cause of dulness in the upper abdomen, but it could not by itself be the cause of such severe pain, great tenderness, and leucocytosis.

Chronic mediastinitis has no acute symptoms, and no symptoms whatever until the later stage when venous obstruction becomes considerable; until then the patient is unaware of its presence. Its first symptom is dyspnœa, and this only when hypertrophy and dilatation of the heart begin to be present. With the dyspnœa there may be slight retraction in the interspaces in any part of the chest during systole and restriction of normal cardiac mobility when the patient is turned on the left side. The pulsus paradoxus may be present; that is, an intermitting or weakening of the pulse during inspiration. Such a pulse, however, has been observed physiologically and in other conditions which lessen the entrance of air into the lungs; it is not by itself a diagnostic sign of obliterative mediastinitis. Other signs, such as Broadbent's and Freidreich's, have been dwelt upon and are of not much diagnostic value.

We have here a case of a chronic obstructive process in the mediastinum, starting, in all probability, as an infection

from the bronchial or mediastinal glands, possibly primary in the peritoneal cavity. This had already caused chronic hyperæmia of the liver and marked enlargement, notwithstanding which the boy had felt perfectly well until the slight febrile attack following prolonged immersion in the salt water. Previous to this he had had no dyspnœa, no abdominal pain and tenderness, although the liver was passively congested and enlarged on account of the mediastinal obstruction. The symptom complex was caused by the two factors, the acute pericardial infection and the chronic mediastinal obstruction with an enlarged liver. The infection and distention of the pericardium increased the mediastinal obstruction, increased the congestion of the liver, and added an element of perihepatic inflammation. The acute congestion of the liver following the pericardial infection by extreme stretching of its capsule added to the pain which the pericarditis alone would have caused and accounted for the exquisite and wide-spread tenderness.

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TRANS-DUODENAL CHOLEDOCHOTOMY FOR STONE IN THE AMPULLA OF VATER;

WITH FISTULOUS COMMUNICATION BETWEEN THE GALL-BLADDER AND THE DUODENUM.

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MRS. R. McI., white, aged thirty-two years, native of Arkansas and resident of north central Louisiana, was admitted to St. Mary's Hospital at Patterson on April 12, 1912, with a history of repeated attacks of epigastric pain and jaundice.

Family history negative. The patient herself, with the exception of a moderately severe attack of typhoid fever five years ago, and the complaint for which she now seeks relief, has never been ill. She has been married for seven years and has three children. The menstrual history is negative. Her present illness began some three years ago, with a severe attack of abdominal pain accompanied by vomiting and fever, with slight jaundice. She was very ill at this time; the condition was diagnosed as gall-stones, and an operation expected, but this was ultimately decided against. Convalescence was very prolonged. Since then she has had attacks of biliary colic at intervals varying from a month to three or four months. At each seizure there is jaundice, which is never very deep, and which comes on usually two or three days following the pain. Within the last four months the attacks have become very much more frequent, as often as every week or two, so that she has been constantly jaundiced during that time. She has lost fifteen or twenty pounds in weight, her appetite is good, and bowels constipated. Typically clay-colored stools have never been noticed. She suffers slightly from indigestion and flatulency, feels constantly a sensation of weight in the right hypochondrium, and frequently has pain in the right shoulder.

Status Præsens.—Height 5 feet 6 inches; weight 158 pounds. She is of an extreme blonde type and the skin of the body is definitely jaundiced, as are the conjunctivæ, but the jaundice is not deep. Thoracic organs are normal. Abdominal palpation

is negative until the right upper quadrant is reached; here it is found that the liver is normal in size, there is no palpable tumor, there is slight tenderness over the gall-bladder, and firm pressure here elicits rectus rigidity and causes a sensation of nausea. Vaginal examination negative. The urine is normal in quantity and contains bile, but no other abnormalities. The blood examination shows reds 4,800,000, whites 8000.

Operation was made on April 13, as follows:

Ether anæsthesia. The abdomen was opened through the right rectus muscle by a vertical incision, which was later prolonged upward and inward (Mayo-Robson type). The gall-bladder area was occupied by a mass of adherent structure, consisting of colon, omentum, duodenum, and the gall-bladder itself; and it was with some difficulty that the latter viscus was brought into view. It was slightly smaller than usual. There were dense adhesions which connected it intimately with the second part of the duodenum, the appearance being one suggesting fistulous communication. Across the gall-bladder, and constricting it at a point three-quarters of an inch from its junction with the duodenum, was a strong band of adhesions which caused a sharp angulation of the gall-bladder at this point. The walls of the gall-bladder were only slightly thickened and it contained no stones. Pressure emptied it of the small amount of bile which it contained. There were no stones in the hepatic duct and the common duct was free as far as its third portion. Behind the duodenum was felt a mass which was evidently a stone lodged in the third portion of the duct. The pancreas was normal.

The duodenum was freely movable after all adhesions (except with the gall-bladder) had been loosened; but as there was constant oozing, which obscured the field, it was thought best to remove the stone by the transduodenal route. A longitudinal incision was, therefore, made in the anterior wall of the duodenum, with its centre over the stone. The duodenum upon being opened was found to contain bile which had been expressed into it through the fistula in previous manipulations. The fistulous opening itself was about one-quarter inch in diameter. (This had evidently been caused by the previous passage of a large stone; probably at the time of her first attack.) The bile papilla was easily found, and an attempt made to dilate it for extraction

of the stone. This could not be done, and the anterior wall of the ampulla was therefore incised and the stone removed. It was about the size of a small cherry, and was very soft in consistency. No further stones were found upon probing the ducts, but there was a small amount of inspissated bile in the duct above the stone itself. No suture was put into the roof of the ampulla. The duodenum itself was closed by one layer of catgut and one of linen. The question then arose as to the advisability of freeing the gall-bladder from the duodenum, removing it, and closing the fistulous opening. There was no evidence of any active infection present, however, and this, together with the fact that by allowing the condition to remain as it was there was a natural provision for drainage in two directions, and finally the desirability of completing the work with as little loss of time as possible all argued against the advisability of this additional point in technic. The gall-bladder with its duodenal communication was therefore not disturbed. A small cigarette drain was inserted down to the foramen of Winslow and the wound closed in tier suture. The time of operation was forty minutes, and there was no appreciable shock.

The after-treatment was of the usual sort. There were no bad post-operative symptoms at any time. Drain was removed in 48 hours. Jaundice cleared up very rapidly. Patient left the hospital 16 days after the operation (April 29). A letter received from her four weeks after discharge states that she is feeling perfectly well.

The case is of especial interest from two points of view: The frequent attacks of biliary colic, followed always by jaundice, in the presence of a fistulous communication with the bowel which was apparently sufficient to insure free drainage at all times, is the first. This may be explained by assuming that there occurred frequently a mild cholecystitis, resulting in the œdematization of the mucous membrane of the gall-bladder and the consequent closure of the cholecystduodenal opening; and possibly this was aided by the constriction of the gall-bladder by the adhesion-band above spoken of. That the icterus was never very deep and always disappeared rapidly would also tend to confirm this supposition. The second point

of interest is in regard to the omission of gall-bladder drainage or removal of the gall-bladder. I am unable to find any precedent for this. Without exception, as far as I have been able to inform myself, when transduodenal choledochotomy is done, there is always an additional cholecystostomy made, or the gall-bladder is removed and the duct drained. In this case, so far as infection was concerned, there seemed to be no indication; and had infection been present except in a severe type) an additional natural provision for drainage was at hand to serve the purpose. To have removed the gall-bladder, closed the opening in the duodenum, and drained the common duct would have been to needlessly prolong the operation and add greatly to the post-operative dangers.

Since the writing of this report there appeared in *Surgery, Gynæcology and Obstetrics,* May, 1912, page 438, column 2 and paragraph 3, the following statement by Dr. George Emerson Brewer, in reporting a case of a similar kind:

"In any event it would have been wiser to have left the gall-bladder and its fistula intact and to have removed the foreign body in the common duct by a simple transduodenal choledochotomy. It would have saved much time and manipulative trauma, and insured two duodenal outlets for the bile."

I am fortunate in having run across the coincidence, and am glad that my omission in technic is, even indirectly, supported by the opinion of a surgeon of such eminence.

ACUTE PHLEGMONOUS INFLAMMATION OF THE LARGE INTESTINE.*

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We do not often have to deal with extensive inflammation in the wall of the large intestine. Occasionally we find inflammation extending from the appendix into the wall of the colon, so that the appendical stump cannot be buried or inverted.

We have also learned to look for diverticulitis in the lower part of the large intestine; and, of course, we have long known about the inflammation of the large intestine which is called colitis, which begins primarily in the mucous membrane, which leads to a destruction of parts of that membrane, and which sometimes involves the underlying coats.

Acute extensive inflammation which has attacked the wall of the large intestine so as to present a serious surgical condition has not been often reported.

A patient presented before the New York Surgical Society, March 27, 1912, illustrates this condition. He is a strong young man, twenty-three years of age, who was admitted to Roosevelt Hospital, September 15, 1911. He stated that during the past year he had had pain in the left side of his abdomen more or less of the time. This pain came in indefinite attacks. He thinks that during the entire time he may have vomited three or four times. Two and a half days before admission, this pain began in moderate severity. For 24 hours it had been very severe, he had passed blood in his stools, had not vomited, but had had nausea. On the day of admission, he passed a large amount of blood and came to the accident ward very ill, very much prostrated, complaining of great pain along the left side of his abdomen. His pulse was 92, temperature was 98°, but he looked profoundly prostrated and had much muscle spasm on the left

* Read before the New York Surgical Society, March 27, 1912.

side of the abdomen. No definite diagnosis was made, but his extreme prostration and bloody stools indicated that he had a severe lesion of some sort and the location of the pain and muscle spasm indicated that this lesion was in the left side of the abdomen. Exploration seemed imperative. An incision was made at the outer side of the left rectus. The descending colon from the splenic flexure down to the sigmoid was found to be intensely red and hard, the wall was so thickened that it seemed almost a solid mass, and the consistency was nearer that of a garden hose than that of the normal intestine. It seemed as though the lumen was filled up by the infiltration in the intestinal wall. The lesion seemed so severe and the patient so ill that I considered it best to resect this portion of the intestine. It was done without difficulty, and a lateral anastomosis was made between the middle of the transverse colon and the sigmoid flexure. Following the operation, the man was very ill for three or four days. He was delirious, had to be restrained in bed and acted profoundly disturbed, but finally made a satisfactory recovery, although it was slow and complicated. At no time did he have a very high pulse or a very high temperature.

During the winter, he has been in his usual health. An X-ray picture which has recently been taken shows satisfactory continuity of the large intestine. He has not suffered materially from either constipation or from diarrhœa; his tendency is toward the former condition.

The pathological report is as follows: Specimen, large intestine.

Gross Examination.—The specimen consists of a resected portion of the large intestine, 22 inches long, dark red in color, with a thickened œdematous wall. The lining is covered with tapioca-like papillæ. The lumen contains a large amount of mucus.

Microscopic Examination.—The peritoneal surface is slightly thickened, the muscularis is infiltrated with polynuclear cells which separate the muscle fibres.

The submucosa is very œdematous and infiltrated with polynuclear cells. Enlarged lymphoid follicles lie underneath the mucous membrane. Some of the mucosa is intact, but most of it has been replaced by a purulent exudate. Gram stain reveals numerous groups of Gram-positive cocci in the submucosa.

Diagnosis.—Acute suppurative inflammation.

We have considerable definite information about phlegmonous inflammation in the wall of the stomach. Robin-

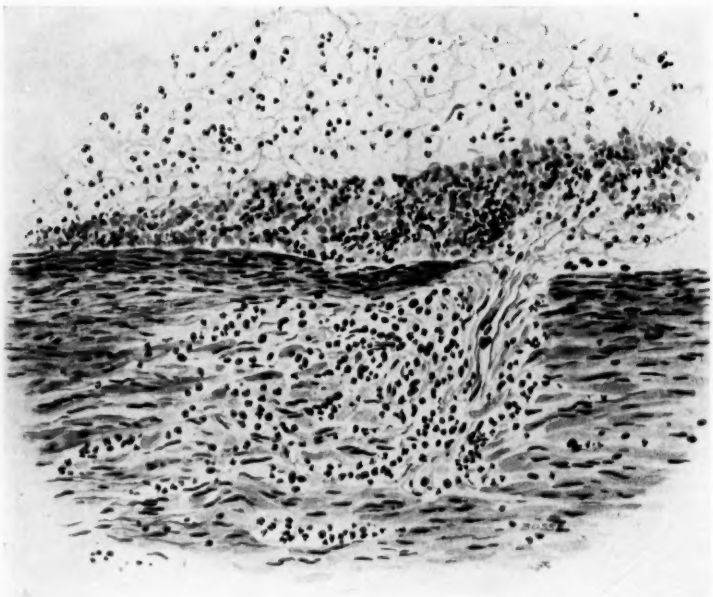
FIG. 1.

Gross appearance of section of intestinal wall, showing œdematous thickening and prominence of the follicles of Lieberkühn.

FIG. 2.

Microscopical section of intestinal wall (low power), showing œdema in the submucosa and erosion of the mucosa.

FIG. 3.



High-power detail of submucosa and muscularis, showing œdema and polymorphonuclear infiltration.

FIG. 4.

High-power detail of mucosa, showing œdema, exudation, and destruction of part of epithelium.

son (*Jour. A. M. A.*, Dec. 26, 1909, p. 2143) has added 8 cases to the 83 which had previously been tabulated by Schnarrwyler (*Archiv. f. Verdaurgster-Bull.*, 1906, xii). The description of these cases has been carefully given in many instances. Baird (*Am. Jour. Med. Sc.*, Nov., 1911, p. 6488) has made a more recent contribution to the subject. The lesion is mostly situated in the submucosa, streptococci are usually the cause of the inflammation, and they lead to an infiltration which corresponds very much to that which these organisms produce elsewhere.

The port of entry has usually been a gastric ulcer. The patient has been overwhelmed with the severity of the infection—98 per cent. of the reported cases have been fatal.

Although we have not many reports of similar infections in the large intestines, we have still abundant evidences that there are infections there which have not been very clearly understood. Delafield and Prudden (*Handbook of Path. Anat. and Histol.*, 9th ed., p. 681) for instance refer to a "very fatal and obscure form of necrotic colitis which appears to be septic in character. After death the inner surface of the colon is found studded with little blackish areas in which the blood-vessels are gorged with blood. The glandular and connective-tissue coats are infiltrated with pus-cells and there is a superficial necrosis. Various forms of micro-organisms have been found in connection with suppurative and necrotic lesions of the ileum and colon—*Streptococcus pyogenes, Staphylococcus pyogenes aureus, Bacillus coli communis, Bacillus proteus*, etc., etc."

Ziegler (*Text-book of Special Pathological Anatomy*, tenth edition, p. 662) refers to inflammation of the large intestine as sometimes due to septic infection.

It is altogether probable that the man had had a diverticulitis or an abrasion of the mucosa by fecal masses, and that an acute phlegmonous inflammation was added to this, just as similar inflammations have existed in the stomach or in the subcutaneous tissues in various parts of the body. The condition of the blood-vessels showed that it was not a mesenteric thrombosis.

THE RECOGNITION AND TREATMENT OF LESIONS OF THE RIGHT ILIAC FOSSA OTHER THAN APPENDICITIS.*

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EVER since Fitz's memorable paper in 1888, the right iliac fossa has been of great surgical interest. The frequency of appendicitis in this country has contributed to a thorough study of its varied pathology, and while for many years the treatment was the subject of great controversy, we now seem unanimously of the opinion that every case of acute appendicitis should be operated on at the earliest possible moment, except that most surgeons, probably the great majority, postpone operation for a time in the presence of spreading peritonitis. The experienced surgeon alone, however, can decide the question in each case. As a general rule we operate in every case of chronic appendicitis whether local pain alone is experienced or whether certain referred symptoms, often popularly called appendiceal dyspepsia, are present.

Ewald in 1899 stimulated the study of chronic appendicitis by a description of the type called appendicitis larvata and for a time much operating was done, usually with beneficial results but sometimes without relief of the symptoms complained of. We went through an era of more or less indiscriminate removal of the appendix in operations for other lesions in the pelvis and here again much good and some harm was done. We did learn, however, something more of the pathology of the presumably normal appendix and our microscopists often startled us with their diagnoses when symptoms of appendicitis had apparently never existed. Many surgeons made the so-called buttonhole incision, reached in, felt and removed the appendix but saw nothing more of the state of the viscera.

It is interesting to note how few studies have been published

* Read before the Academy of Surgery of Philadelphia, May 6, 1912.

until recently regarding the end results in chronic appendicitis, although many loose statements are scattered through the literature regarding this matter. Graham and Guthrie in 1910 (*Jour. A.M.A.*, 1910, 54, p. 960) reported a series of cases of chronic appendicitis of the dyspeptic type which were traced a year or more after the operation, with the result that approximately 85 per cent. were cured or improved, 10 per cent. suffered from an occasional return of symptoms, and 5 per cent. were not cured by the operation. Stanton in 1911 (*N. Y. State Journ. of Med.*, 1911, vol. xi, p. 479) also studied 100 cases operated under the clinical diagnosis of chronic appendicitis, 64 of which were cured, while in 36 the end results were either unsatisfactory or other lesions were found to be the cause of the symptoms. Wilms, before the Fortieth Congress of German Surgeons, expressed the opinion that the diagnosis of appendicitis was often made too lightly, and he estimated that at least 30 per cent. of so-called cases of chronic appendicitis are cases of chronic constipation with a movable, dilated, and prolapsed cæcum. Klemm, Hausmann, Stierlin, and others have made similar statements. On the other hand, recently Scudder and Goodall (*Boston Med. and Surg. Jour.*, 1911, clxv, p. 6), reviewing the returns from 640 cases of appendicitis operated upon in the Massachusetts General Hospital, found that 94.6 per cent. of the cases were in good health and were relieved by the operation, and that 4.6 per cent. had poor health due to some definite pathologic reason. The paper is impressive, but the results are somewhat vitiated by the fact that only 640 returns were received from more than 3000 appendectomies.

I do not wish to be understood as opposing operation for chronic appendicitis, but wish to emphasize the necessity for a more individual study of each patient in order to avoid the removal by operation of a normal appendix without further investigation of the right iliac fossa, with the result that the patient will be left in as bad if not worse condition than before.

These patients exhibit attacks of pain, usually at McBurney's point, a sensation of dragging in the right iliac fossa,

sometimes a tenseness or distention in the same locality, and irregularity of the bowels, usually constipation. Certain referred symptoms, of which " dyspepsia " is the most common, are also often present.

Now, given a series of these symptoms, what is the common practice? With or without a fairly accurate history of an acute attack in the past, with pain in the right lower quadrant, at times with reflex stomach symptoms, the practitioner or surgeon palpates the appendiceal region and finds a little tenderness to deep, *hard* prodding, and without further parleying diagnoses chronic appendicitis and may advise operation. As a matter of fact he is right in the majority of cases, and this confirms his estimate of his diagnostic acumen, but a certain percentage of the patients operated on will *not* be relieved by operation and then adhesions are discussed and perhaps a second operation advised.

The difficulty seems to be in that group of cases where symptoms suggesting chronic appendicitis are present ***without the history of a definite acute attack.*** These are the cases that must be studied anew. When once a principle is established, further progress is mostly along refinements in the diagnosis of the affliction and a study of group statistics. This has led to the recognition of one or more sub-groups, curiously alike symptomatically, but with a pathology differing from the central group, designated at the present time as Jackson's membrane, Lane's kink, and cæcum mobile. There is field for controversy here and the subject must be fully considered before we can establish a definite entity for any one of them. There must be more than one etiologic factor concerned in their production and we must learn to distinguish between the adhesions acquired as the result of infection (peritonitis) and those produced by abnormalities in the development of the gut tube and of its rotation or those acquired as a result of splanchnoptosis (traction adhesions of Lane).

The development of the intestinal tract from the primitive gut has been studied anew of late years and seems to offer a better explanation of the formation of membranes and kinks

than any other, except where a definite previous peritonitis has produced bands and adhesions. It will be remembered that the cæcum descends from beneath the liver to the right iliac fossa, and that its posterior peritoneal surface fuses with the parietal peritoneum; the ascending colon thus acquires an extraperitoneal surface, which originally was intraperitoneal. The lower portion remains free and the extent of the line of reflection varies markedly in different individuals; the colon and cæcum may be entirely free with a distinct mesocolon and may hang far down in the pelvis, or the entire posterior surface of the colon and cæcum and even the termination of the ileum may be extraperitoneal. Somewhere between the two extremes the normal is found.

Jackson's Membrane.—In 1909 Jackson, under the title of membraneous pericolitis, described a lesion of the cæcum and ascending colon, consisting of a thin vascular veil binding the colon to the abdominal wall and resembling the œdematous arachnoid seen in the wet brain of a dead alcoholic. Jackson remarks: "The colon seems placed in a diaphanous bag, slightly too short to contain it without wrinkling." The membrane does not resemble the ordinary adhesions in that it does not enter into a close organic union with the peritoneum of the gut and abdominal wall; instead, it may be stripped off as a veil, after which the serous coat of the bowel appears. The literature upon intra-abdominal adhesions is very great and it is difficult to isolate the articles bearing directly upon this subject. Virchow wrote of the lesion, and certain German surgeons, notably Credé, Lauenstein, and Riedel, advocated operation for severe continued abdominal colic and the removal of adhesions; Lane had discussed a similar, perhaps the same, condition under the term of traction adhesions, but the lesion under consideration, in the sense of a pannus, seems first to have been described accurately and adequately by Jackson (*Surg., Gyn. and Obs.*, 1909, ix, p. 278) in both its pathologic and clinical aspects. Binnie in 1905 described a similar condition.

The etiology of this condition has not yet been cleared up, there being two conflicting opinions, viz., that it is due to cer-

tain congenital anomalies during the rotation of the large intestine or that it is the result of infection. Blake (ANNALS OF SURGERY, 1912, lv, 767) has recently stated that the so-called Jackson membrane was present always and was in fact a normal structure. But such an opinion in view of the observations of many reliable observers must be erroneous. Gerster (ANNALS OF SURGERY, 1911, liv, 325) in an excellent paper ascribed the lesion to a chronic colitis as the starting point of an infection which causes a reaction of the peritoneum. Pilcher (ANNALS OF SURGERY, 1912, lv, p. 1) in an excellent paper on membraneous pericolitis believes it to be the result of long-continued or oft-repeated mild infections of the peritoneal covering of the cæcum and appendix, transmitted through the intestinal wall. The congenital factor may have a predisposing influence. It is interesting to recall that Hofmeister found the *Tricocephalus dispar* in a number of his cases. On the other hand, Mayo (*Surg., Gyn. and Obs.*, 1911, xii, 227) believes that "this condition is undoubtedly due to the late rotation of the bowel and descent of the cæcum from its hepatic position after the formation of the parietal portion of the peritoneal cavity in the infant. The cæcum burrows its way into position, as it were, through the peritoneum."

The symptoms of membranous pericolitis, as formulated by Jackson, are pain and tenderness, constipation, gaseous distention most marked over the cæcum, mucous discharge from the bowels, loss of weight and tone, various forms of gastric indigestion, and neurasthenic manifestations. This group of symptoms will be seen to correspond pretty closely to those described for many years as being caused by visceroptosis; they are dependent upon the stagnation of the fecal content of the bowel and their absorption. Pilcher described the pathologic complex as (*a*) defective peristalsis from the mechanical action of the veil or adhesions; (*b*) real obstruction from bands; (*c*) enterospasm from persistent irritation, and (*d*) auto-intoxication.

Jackson recommends that the membrane should be entirely dissected off the colon, and reports seven cases in which this

was done with gratifying results and only awaits the lapse of time to see if the results remain permanent. After the operation it is important to revive the sluggish peristalsis by regular habits, antifermentative diet, occasional catharsis, and abdominal gymnastics and massage. Connell (*Surg., Gyn. and Obs.*, 1911, vol. xiii, p. 485) twists the membrane into a cord and fastens it to the abdominal muscles, thus keeping the cæcum up and out of the pelvis.

Lane Kink.—The kink is manifested by an acute bend of the ileum about six inches from its termination, due to a thickening or contraction of the mesentery at that point or to an adhesion of adjacent arms of the angle or of the bowel to its mesentery. It may be congenital or acquired, the former being the result of a change in the position of the viscera, especially the cæcum, or an abnormal disposition of the small bowel. As a result there develops on the under surface of the mesentery of the last few inches of the small intestine a new band which at first forms part of the under surface of the mesentery. Later, a distinct ligament forms which subsequently contracts, drags on the ileum and produces kinking, especially when the patient is in the erect position. The symptoms of the Lane kink as described by Franklin Martin (*Surg., Gyn. and Obs.*, 1911, vol. xii, p. 33) and Mayo (*Surg., Gyn. and Obs.*, 1911, vol. xii, p. 227) differ but little from the familiar symptoms ascribed to visceroptosis in general, except that the region of the kink is often tender, the area extending from the umbilicus downward to the right, and the pain is increased by peristaltic activity, especially when caused by the activity of the individual. "The intestinal and gastric symptoms are often most marked at fairly regular periods after eating, and frequently there is a distention of the small intestine in evidence when the individual is fatigued" (Mayo). Malaise, headache, backache, anorexia, nausea, and all the other symptoms that are characteristic of gastro-intestinal stasis may be present, together with toxæmia from the coexisting chronic constipation. Most cases will be diagnosed as chronic constipation, some will be operated on with the knowledge that a dilated cæcum exists,

but we may surmise that a kink is present and confirm the diagnosis by an inspection at the time of operation. Jordan (*Lancet*, 1911, clxxxi, and *Brit. Med. Jour.*, 1912, i, 1225) emphasizes the importance of accurate X-ray studies, and publishes some excellent illustrations of the Lane kink.

The acquired variety of the kink is mostly caused by appendicitis or pelvic infections which by producing an adhesive peritonitis cause an angulation of the ileum at the point of contact. It is beautifully shown in the case of intestinal obstruction following an appendicitis with operation where drainage is employed, the ileum knuckles at its point of adhesion to the tract. The treatment of the Lane kink consists simply in the separation of the adhesions and bands by the knife or scissors or by sponge dissection. The ileum should be drawn taut to reveal the adhesions, and in all cases the cæcum should be so elevated that it does not make traction upon the insertion of the ileum; in rare cases in which all of the anomalies coexist and extreme degrees of ptosis with kinking at all the flexures exist, it may be necessary to perform the more serious operations of exclusion of the colon or of excision of the entire colon. If operation is not performed the patient should be treated with belts, exercise, diet, and all the other measures recommended in the treatment of visceroptosis.

I have observed the Lane kink in a number of cases since my attention was first called to its existence, and make it a practice when operating for any abdominal lesion to examine the ileum, cæcum, and colon, when feasible, for abnormalities. In two of the cases, a movable and dilated cæcum was also present, for which condition I performed Wilms's fixation operation; the histories of these cases will be given later. In the following case I found both a Lane kink and a chronic interstitial appendicitis and it was therefore difficult to determine which condition was the cause of the symptoms:

This patient, a man, age 39 (R. M. G., No. 10,202), commenced to be troubled with his stomach about six or seven years before, starting with pain in the epigastrium, distention and

eructation of gas. The pain came on some time after meals, but he at no time had acute attacks suggesting biliary colic. He occasionally eructed some bitter material. The pain was dull in character rather than sharp, and was occasionally relieved by vomiting. He was constantly constipated. Physical examination was negative except for slight tenderness over the appendiceal region. There was a moderate anæmia.

Operation (December 6, 1911).—Through a McBurney incision the appendix was exposed on the inner and under surface of the cæcum. It was hard and infiltrated, evidently of the chronic interstitial type. Further exploration revealed a well-developed band in the mesentery of the ileum (Lane kink), which was removed and the raw surface covered by a continuous suture in the peritoneal folds on either side. Owing to the fact that the patient had many symptoms pointing to a gall-bladder lesion, an incision was made in the right rectus, but the findings were negative.

In another case the patient had symptoms of appendicitis and the appendix was removed in another hospital about nine months before I first saw him. This patient (W. B. P., 10,017) was 21 years of age and a tailor by occupation. His previous history was negative. No drainage was employed in the previous operation, but since then he has complained of pain and a sensation of heat in the right lower abdomen. The pain is constant and dull, as a rule, but is occasionally sharp and short in character. It is not associated with eating nor with the state of the bowels; he is usually constipated and complains of some dizziness. Operation was performed on September 5, 1911, and the omentum found adherent to the scar of the old wound, but in addition there was a well-marked Lane kink of the ileum.

That a Lane kink may be acquired as the result of appendicitis is illustrated by the following case:

E. V. W. (index No. 10,985), age 38. About 18 years ago the patient had an attack of abdominal pain lasting three days and necessitating medical attention. The attack recurred one week later and also lasted for three days. Since these attacks he has had indigestion in the form of epigastric pain about one hour after taking food. Sometimes the pain would immediately follow

eating; it was then severe, sharp, and burning in character. When the pain comes on an hour after meals it increases gradually in intensity and is aching in character. One year ago patient suffered from a severe attack of pain in the epigastrium, with vomiting, which lasted for about one week; the symptoms were increased by eating, and were not relieved by taking soda. The attack became less severe and wore off in 1½ months, but he lost 13 pounds in weight. In December, 1911, he had a severe attack of colicky general abdominal pain, localized after a time in the right iliac fossa and lasting for four or five days, with a residual soreness in the lower abdomen for a number of days. With the attack vomiting occurred and was quite frequent during the first day.

The present attack began on March 16, 1912, with severe colicky pain in the midline and just above the umbilicus; there was nausea but no vomiting, and toward evening pain became much less, but the taking of food increased the pain. During the three days before admission the pain practically disappeared and never localized itself in the right iliac fossa, but coughing caused pain in the hypogastrium, and eating or drinking caused pain in the epigastrium. Patient suffers from gaseous distention and belching, but is not constipated. Physical examination reveals a scaphoid abdomen with no rigidity nor mass. The entire right iliac fossa is quite tender, most marked a little to the right of the median line below the umbilicus.

Operation (March 19, 1912).—The appendix was found surrounded by adhesions and pointing downward and inward toward the pelvis. The adhesions were readily separated and the appendix delivered without the abdominal wound, where it was found to be in places completely necrotic. There was no free exudate, but the first two or three inches of the mesentery of the ileum was the seat of an organized inflammatory exudate, simulating, in its position and relations to the ileum, a Lane band. In fact, there was one point in the ileum, about three inches from the ileocecal valve, where there was an evident constriction of the lumen of the bowel. There is no doubt but that the last attack was one superimposed upon the many preceding attacks of appendicitis. The findings of the operation were interesting in connection with the fact that a Lane kink was suspected before the operation was undertaken. Several ligatures were applied to the bleeding

points on the mesentery until hæmostasis was complete. The wound was closed in the usual way.

The report from the Laboratory of Surgical Pathology (No. 3995) revealed the appendix to be in a state of necrosis, the mucosa being entirely replaced by inflammatory and necrotic material, and the coats showing an intense leucocytic infiltration. There were two areas, one near the tip and the other about the centre of the organ, which were greenish-black in color, evidently in a state of gangrene.

Cæcum Mobile.—It is easily understood how anomalies in the descent of the colon may produce undue mobility of the cæcum, and many investigations have been undertaken to determine the frequency with which a movable cæcum exists, and there appears to be much difference of opinion among these observers. The statistics of Wandel (*Mitt. a. d. Grenz. geb. d. Med. u. Chir.*, Bd. xi, S. 39) are perhaps the most often quoted. He found 66 cases of movable cæcum in 640 autopsies. Treves (*Brit. Med. Jour.*, 1885, p. 474) gives approximately the same figures. Recently, Dreyer (ANNALS OF SURGERY, 1912, lv, 164) states that out of a large number of autopsies he has found in 67 per cent. a movable cæcum; in the autopsy room only 11 per cent. of women were found to be free from cæcum mobile.

The term "cæcum mobile" was first employed by Haussman (*Berlin klin. Woch.*, 1904, 44, 1153) in 1904, but it was not until Wilms (*Deutsche med. Woch.*, 1908, 1756) reported, in 1908, that he had operated upon 40 cases that the clinical aspects were appreciated. There is an abundant literature upon this subject at the present time, mostly from the German clinics, and the recognition of a dilated and displaced cæcum is much easier, clinically, than the other conditions I have discussed. It should be understood that mobility alone does not imply that the patient must suffer from symptoms, extreme degrees being perfectly compatible with good health. But it is also certain that an overloaded and dilated cæcum may compress the ileum or drag upon its mesentery, which in time develops thickening and may produce a Lane kink. Lane

also teaches that as the result of excessive mobility traction adhesions develop which endeavor to fix the bowel and prevent its further descent; occasionally, they merely serve the purpose of constricting the lumen of the colon. Finally, the drag upon the meso-appendix interferes with the blood supply and lumen of the appendix, inducing its degeneration and disease. Torsion of the elongated cæcum may occur, Klose (*Münch. med. Woch.*, Feb. 15, 1911) believing this to be the chief factor in the production of symptoms.

On the other hand, Fischler (*Mitt. a. d. Grenz. geb. d. Med. u. Chir.*, 1909, xx, 663) states that he has encountered cases of actual dilatation and atony of the cæcum without appendicitis and the cæcum not necessarily unduly mobile or displaced. Klemm (*Archiv. f. klin. Chir.*, 1909, xcv) also refers to atony of the cæcum, but described a different etiology. He believes that as a result of appendicitis the serosa of the cæcum is affected and the elasticity of the bowel wall impaired; it stretches, and atony follows as a result of fecal stagnation. It also seems probable that any obstruction at the hepatic flexure, as from ptosis, adhesions, or membranes, may produce atony of the cæcum with symptoms. I have observed this in the case of a girl (E. C.), eight years of age, who was admitted to the Episcopal Hospital with the diagnosis of appendicitis. She had complained of symptoms referable to the right iliac fossa and with deep tenderness. A radiograph revealed dilatation of the ascending colon just below the hepatic flexure, that part of the bowel which makes up the flexure being ptosed forward and downward.

The chief symptoms of movable cæcum are, first, colicky pain in the right iliac fossa, mostly without fever, and often accompanied by continuous pain or a sense of soreness in the interval between the attacks; secondly, constipation with occasional short attacks of diarrhœa, especially at the conclusion of the attack of colic; thirdly, in the region of the cæcum a local distention may be palpated which gives a sense of elastic resistance and which upon gliding palpation reveals gurgling or splashing sensations; fourthly, bismuth radiographs made with the patient in the erect, recumbent, and Trendelenburg posi-

tions will reveal the position and size and shape of the organ.

Gastric disturbance (appendiceal dyspepsia, etc.) is not a marked feature of the attack in uncomplicated cases. If it does exist it may be due to chronic appendicitis, to associated gastroptosis, or to some other pelvic or upper abdominal complication. Stanton showed this very clearly in the analysis of his cases of chronic appendicitis. Of the 64 patients cured by appendectomy he noted that in 96 per cent. there was a history of epigastric or mid-abdominal pain or distress; whereas of the 36 in which the end results were unsatisfactory the patients complained almost without exception of pain in the right lower quadrant as their chief symptom, and the occurrence of gas was very noticeable in the case histories. Lardennois (*Presse Médicale,* June 4, 1910) describes the following pathognomonic signs: When the contents of the transverse and ascending colon are pushed back toward the cæcum, pain in the right pelvic region is produced; while the pain disappears if the contents of the prolapsed cæcum are gently pushed from below upward toward the colon. He believes that disturbances from movable cæcum have frequently been erroneously ascribed to wandering kidney, ovarian cysts, varicocele of the broad ligament, displacements of the uterus, and various neuralgias or neuropathies.

The treatment of cæcum mobile at the present time has not been placed upon a rational basis. We must remember that the cæcum is normally movable, and it is only when it becomes dilated by reason of obstruction in the colon or excessively mobile by reason of congenital anomalies that serious symptoms result. The work of Wilms has been accepted by many German surgeons: Haussman, Klose, Stierlin, Rehn, Wolker, and others regard surgery as the only satisfactory remedy. But Sonnenburg [1] believes that a patient is better with a

[1] Since the above was written, Bevan, at the 1912 meeting of the A. M. A., stated that the mere movability of the cæcum can of itself alone give rise to trouble no more than can a normal ileum or a normal sigmoid, both of which are much more movable than the so-called mobile cæcum.

cæcum mobile than with a fixed cæcum, and he has not seen much benefit derived from the operation.

Fischler advises a restricted diet with the avoidance of carbohydrate, fat, or albumin; light massage; gymnastic exercises; the avoidance of purgation, and the administration of bismuth, magnesia, and rhubarb. He applies moist heat to the cæcal region by compresses worn during the night, although in very severe attacks the application of cold and minute doses of morphine may be necessary. He believes that atony, with stagnation of the contents and local meteorism, is responsible for the trouble and that operation will not be successful. One thing we must remember: it is exceedingly dangerous, unless the diagnosis is perfectly clear, to teach a non-operative method of treatment for attacks of pain in the right iliac fossa.

As to the method of operating, there may be said to be three methods in technique. Klose sutures the cæcum throughout its entire length to the lateral abdominal wall, the suture taking up only the serosa of the bowel and fastening it as far back as possible. Wilms makes a vertical incision in the parietal peritoneum about one inch from the peritoneal reflection and sutures the upper edge of the cut peritoneum over and onto the cæcum, thus pushing the cæcum into a retroperitoneal pocket. Klemm (*Archiv. für klin. Chir.*, July, 1911, p. 588) refers to plication in the unusually redundant form, and Blake (ANNALS OF SURGERY, 1912, lv, 767) plicated the wall of the cæcum by a continuous Cushing suture of linen, commencing at the site of the appendix and uniting the ventral and lateral tæniæ or striæ musculares together aborally along the ascending colon for a sufficient distance, usually 4 or 5 inches, to produce the desired effect. As the continuous suture is introduced and drawn tight, the length, and therefore the pendulousness, of the cæcum is diminished, as well as its calibre. The appendix is removed at the same time. As to the result of operation, no definite conclusions can yet be drawn. Stierlin, in reporting from Wilms's Clinic (*Deutsch. Zeit. fur Chir.*, 1910, 106, 407), refers to 61 cases, with a cure in 75 per cent., improvement in 16 per cent., and no improvement in 9 per cent.

Klose (ANNALS OF SURGERY, 1912, lv, 163) reports 154 cases operated on since 1904, with a complete cure in 89 per cent.

The two following cases, gathered from my recent experiences, are quoted as illustrative of cases of mobile cæcum in which the Wilms operation seemed indicated:

CASE I.—E. K. (10,399), age 24; was admitted to the University Hospital with a history of having suffered since the onset of menstruation with attacks of pain in the right iliac fossa. Two years ago the attacks became more severe and began a few days before the onset of menstruation and rendered her unable to occupy any regular position in business. Between periods she frequently suffered from bilious attacks independent of the quality or quantity of the food taken, although at times she suffered from a "dragging sensation" in the right iliac fossa which turns into a "sweeping pain" which moves up toward the epigastrium. Vomiting frequently occurs with the pain and sometimes relieves it. She has no pain regularly following the taking of food. She is frequently distended with gas. The bowels are constipated and require almost daily the taking of mild cathartics. Backache and headache are common.

Operation (January 7, 1912).—Appendectomy and fixation of the cæcum: Through an oblique incision over McBurney's point extended in either direction so as to give a more adequate exposure, the structures of the right iliac fossa were explored. An elongated and mobile cæcum was revealed, and to its outer side the appendix, seven or eight inches long, sharply flexed at about the junction of the middle and lower thirds, at which point a firm band of adhesion anchored it to the posterior wall of the abdomen. The appendix was removed. About 3 inches from the ileocecal valve Lane's kink was discovered. The band was divided and the raw surface of the peritoneum closed with continuous suture. To fix the cæcum, an incision was made in the parietal peritoneum, the edges of which were bluntly dissected both up and down, thus forming a pocket into which the cæcum was introduced and secured in place by a continuous linen suture between the longitudinal band of the cæcum and the upper margin of the peritoneal incision. The pelvic organs were examined, with negative results. The abdominal wound was closed and the operation concluded with a dilatation of the cervix, with curettement.

Pathological Report of Appendix.—Specimen consists of an appendix measuring 14 cm. in length, with a diameter varying from .8 cm. at the base to 4 cm. at the tip. The surface is rather pale and shows practically no congestion, but there are many fine adhesions, especially near the tip. On section the coats appear normal.

On microscopic sections many of the glands are seen to be somewhat dilated and filled with secretion. There is marked congestion of the small blood-vessels in the mucosa and here and there quite considerable areas of hemorrhage in the lymphoid tissue. The other coats are not involved. Pathological diagnosis: acute catarrhal appendicitis.

Case II.—E. B. (10,557), age 54, is a well-nourished adult female without any of the stigmata of visceroptosis. She has been married for 33 years and has had one child. She is generally constipated, requiring the frequent use of cathartics, but is not obstinately so, nor is the constipation worse at the time of her attacks. Her digestion is generally good, although gaseous distention and eructations are common. She passed the menopause four years ago, and had no trouble previously with menstruation. She suffers from attacks of pain in the right iliac fossa lasting 12 to 24 hours and occurring every month for nearly four years. She often gets nauseated, but rarely vomits during the attack. The pain sometimes radiates over the abdomen, but is usually confined to the right iliac fossa. The attacks are followed by great soreness, necessitating a stay in bed of from one to three days. There seems to be no cause for the attacks, the quality and quantity of food making no difference.

Upon admission to the University Hospital, we elicited nothing further except that the cæcum seemed to be large and gurgled on pressure. Pressure neither over McBurney's point nor on the opposite side caused any pain. She was thought to be suffering from chronic appendicitis.

Operation (February 14, 1912).—Appendectomy; fixation of cæcum: Through a McBurney incision, the cæcum and appendix were exposed and the former found to be redundant and atonic and the latter bound down to the posterior wall of the abdomen, occupying a position behind the cæcum. There had evidently been a number of previous attacks of appendicitis, as the appendix itself was very brittle and the meso-appendix tre-

mendously infiltrated. After the appendix was removed, a vertical incision was made in the lateral wall of the abdominal cavity and a pocket made for the cæcum by dissecting the peritoneum off a distance of an inch above and below the line of incision. The cæcum was then secured in place by a continuous suture of linen introduced through the superior margin of the peritoneal incision above described and the longitudinal band of the cæcum. There was, in addition, a moderately well developed Lane band, about three inches from the ileocecal valve; the band was divided and the raw peritoneum closed with continuous suture. The appendix (Lab. No. 3928) showed microscopically a marked thickening of the submucous and muscular coats with fibrous tissue overgrowth and a general appearance of progressive atrophy, as would be expected in a woman of this age. Patient made an uninterrupted recovery from operation.

It is impossible as yet to formulate any definite conclusions of the three conditions which I have just discussed. It will be necessary to obtain statistical information before the Lane kink will be accepted as a definite cause for symptoms referable to the right iliac fossa. I refer, of course, to the congenital type, and not to that acquired from adhesions, the result of a peritonitis, either arising from diseases of the appendix or other organs. While it is possible for a mobile cæcum to exist as a result of abnormalities in the descent of this portion of the bowel, it is probable that in most cases a dilated and atonic cæcum has resulted from some obstruction in the shape of membranes or bands wrapped around the ascending colon or kinks or adhesions at the hepatic flexure.

As to the symptoms, there seems to be no way of distinguishing the type of lesion with any degree of accuracy, except through the agency of the X-ray. Pictures made with the patient in the erect, recumbent, lateral and Trendelenburg positions will show the degree of mobility of the cæcum, the presence of adhesions, kinks, etc. The mere retention of the bismuth meal in the cæcum for a prolonged period of time does not necessarily imply obstruction to peristalsis; the physiology of the colon is not as yet definitely understood, although Cannon,

Holzknecht, Hertz, and others have done a great deal recently toward the elucidation of its physiology. It is possible in some cases to palpate the distended cæcum, but the symptoms of the Lane kink, of Jackson's membrane, and of cæcum mobile are singularly alike, and in many cases indistinguishable from those which we have been taught are indicative of chronic appendicitis. A statistical study of carefully-taken histories, a comparison of X-ray pictures and a careful recording of the findings of the operating table, the living pathology, as it were, are necessary in order to determine for the future what these conditions really mean to the patient. At the present time it suffices to say that the buttonhole incision for chronic appendicitis should be discarded; the incision should be large enough in all cases to inspect the surrounding viscera and to be able to correct any malformations or diseases thereof. The treatment of the Lane kink, of the Jackson's membrane, and of the cæcum mobile has been described, my own preference for cæcum mobile being the Wilms operation. Occasionally one will encounter extreme degrees of mobile cæcum with marked dilatation and atony; in such cases the operation of Lane should be performed, the ileum being transplanted into the sigmoid.

A STUDY OF SPRAIN-FRACTURE AS AN ESSENTIAL TO THE OCCURRENCE OF DISLOCATION.*

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In a study of sprain-fracture recently presented before the Academy of Surgery of Philadelphia occasion was taken to make the statement that we thought probably all dislocations were permitted by the primary occurrence of sprain-fracture. Our statement was based on the fact that when tension was made on tendons or ligaments we found that the bony tissue to which the tendons or ligaments were attached, and not the tendons or ligaments, gave way (Ross and Stewart).[1] Therefore we reasoned: since the integrity of joints is maintained by strong ligaments, a luxation must occur by a giving way of one or more of the strong ligaments, and this giving way must be by the occurrence of sprain-fracture, and not by rupture of the ligaments. This reasoning applies to ordinary uncomplicated traumatic luxations, not the so-called pathological dislocations (those of slow production due to disease of the joint structures, and not those dislocations due to trauma, that are permitted by rupture of diseased ligaments). In this connection we wish to discuss fracture dislocation, a condition which is well recognized and which we also know is produced most often through the agency of ligaments or tendons, though occasionally produced by direct violence.

Our modern text-books have nothing to say concerning

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* Read before the Philadelphia Academy of Surgery, May 6, 1912.

sprain-fracture by itself or in connection with dislocation excepting in a very vague and indefinite way that obtains in their discussions of symptomatology and treatment. Nevertheless, they seem to be unanimous in the opinion that sprain-fracture under any circumstance is rare.

EXPERIMENTAL DISLOCATIONS ON DOGS.

In working for practical verification of the truth of our assertions we made thirty-six attempts to produce luxations in the joints of dogs, which, with two cases previously studied in dogs, allowed an observation of the pathology in thirty-eight attempts at luxation carried out on living tissues.

These experiments were carried out at the Laboratories of Surgical Research of the University of Pennsylvania. The animals were completely anæsthetized with ether, as is the rule governing all animal experimentation carried out in the laboratory. Following the production of the dislocations on each dog, that dog was killed by poisoning with illuminating gas while still deeply anæsthetized.

Dog and human anatomy differ but slightly; as applied to this work there is no difference between the two, and, to facilitate the understanding of these experiments, the same terminology used in human anatomy will be adhered to.

EXPERIMENT I.—The left leg and foot were taken in either hand and the foot was then turned outward until the resistance encountered was overcome.

Dissection of the ankle-joint showed no lesion, but an epiphyseal separation from the lower tibia was found.

EXPERIMENT II.—By the method used in Experiment I, the right foot was turned inward until the resistance encountered was overcome.

Dissection showed an internal luxation of the foot, sprain-fracture of the external malleolus, sprain-fracture of the external articular border of the astragalus, and sprain-fracture of the tuberosity of the fifth metatarsal.

EXPERIMENT III.—By grasping the thigh and leg in either hand, placing the thumbs on the external junction of the femur and tibia, and pulling toward the thumbs, an attempt was made to separate the internal articulating surfaces of the femur and tibia.

Dissection revealed a sprain-fracture of the external condyle of the

femur, produced by the short band of the external lateral ligament of the knee-joint, and an epiphyseal separation at the lower end of the femur.

EXPERIMENT IV.—With the thigh and leg grasped in either hand, the leg was forced to bend laterally on the femur in both directions.

Dissection showed an epiphyseal separation at the lower end of the femur.

EXPERIMENT V.—An anterior luxation of the left hip-joint was produced. An assistant held the pelvis to the table while the femur was carried through the motions Allis [2] described for the production of such a luxation.

Dissection of the joint showed anterior luxation of the head of the femur, epiphyseal separation at the upper end of the femur, sprain-fracture involving the head of the femur where the posterior inferior portion of the capsular ligament was attached, sprain-fractures at the sites of attachment of most of the tendons in this region, and fracture of each trochanter.

EXPERIMENT VI.—By the means described in Experiment V, a posterior luxation of the right hip was produced according to the method described by Allis.

Dissection of the hip-joint permitted the detection of a posterior luxation of the head of the femur, an epiphyseal separation of the great trochanter of the femur, a sprain-fracture of the acetabulum at the attachment of the ligamentum teres to it, a sprain-fracture of the acetabular rim through the agency of the posterior superior portion of the capsular ligament, sprain-fractures at the sites of attachment of most of the tendons attached in this region, and a pulling from the upper femur (from the trochanters up) of most of its periosteum.

EXPERIMENT VII.—The left arm and forearm were grasped in either hand and, using the thumbs as a fulcrum, the internal joint surfaces were separated.

Dissection exposed a subluxated joint with sprain-fracture of the radius at the site of attachment of the anterior capsular ligament, of the ulna at the anterior attachment of the orbicular ligament, and of the humerus at the attachment of the external lateral ligament.

EXPERIMENT VIII.—Using the same mechanism as in Experiment VII, an attempt was made to separate the external joint surfaces at the right elbow.

Exposure by dissection showed a sprain-fracture of the ulna at the posterior attachment of the orbicular ligament, and an epiphyseal separation at the lower end of the humerus.

EXPERIMENT IX.—Right knee-joint.

EXPERIMENT X.—Left knee-joint.

EXPERIMENT XI.—Right tarsometatarsal joint.

EXPERIMENT XII.—Left tarsometatarsal joint.

These joints were subluxated by grasping the bones above and below them in either hand and forcing motion in those directions where resistance was met with.

On cutting down on these joints it was found that subluxations and sprain-fractures had occurred in all. In the right knee-joint both crucial ligaments were pulled from the femur. However, the anterior crucial ligament alone pulled fragments of bone with it. In the left knee-joint both crucial ligaments pulled bony tissue with them. Both tarsometatarsal joints showed sprain-fractures involving the superior articulating surfaces of the tarsal and, to a lesser extent, metatarsal bones.

EXPERIMENT XIII.—The left elbow-joint was luxated by placing the thumbs on the joint laterally and externally and pulling the humerus and bones of the forearm toward the operator, thus shoving the olecranon and head of the radius inward.

Examination showed luxation inward of the forearm, and a sprain-fracture involving the internal condyle at the attachment of the internal lateral ligament.

EXPERIMENT XIV.—An attempt was made to luxate both wrists by twisting and bending the hand bones on the arm. A giving way was felt.

Incision showed the joints to be intact, but fractures of both bones of the forearm just above the wrist were discovered.

EXPERIMENT XV.—The right humerus was abducted and turned so as to overcome all resistance.

The joint was exposed, showing a subluxation of the humerus, a sprain-fracture of the posterior border of the glenoid fossa produced by the posterior capsular ligament, and a fracture of the neck of the scapula.

EXPERIMENT XVI.—The left shoulder-joint was treated as was the right in Experiment XV.

The humerus was subluxated. Sprain-fractures involving the posterior border of the glenoid fossa and the attachment of the biceps tendon were found.

EXPERIMENT XVII.—The thumbs were placed on the olecranon process of the right arm and the arm and forearm were bent backward on them; after a certain point was reached the humerus and the bones of the forearm took an inward course.

The joint was cut down upon exposing a supracondylar fracture and a pulling away of bony tissue from the internal condyles by the internal lateral ligaments.

EXPERIMENT XVIII.—The same as Experiment XVII, done on the left arm, with the same result.

EXPERIMENT XIX.—The left forearm was held firmly in one hand just above the wrist and the hand was bent back upon it until resistance ceased to exist.

In this way fracture of the bones of the forearm was produced.

EXPERIMENT XX.—The left leg was extended on its thigh until there was a giving way.

Epiphyseal separation from the upper part of the tibia was found.

EXPERIMENT XXI.—The same as Experiment XX, excepting it was done on the right side.

The result was the same as in Experiment XX.

EXPERIMENT XXII.—The left foot was bent outward until a partial luxation was produced at the ankle-joint.

Subluxation of the foot, and sprain-fractures of the internal malleolus and of the tibia and astragalus were found.

EXPERIMENT XXIII.—Experiment XXII was repeated on the right side.

The same result was obtained.

EXPERIMENT XXIV.—Flexion and extension were practised on the right tarsometatarsal articulation until subluxation resulted.

Subluxation and large and small sprain-fractures of the bones involved in the articulation were found.

EXPERIMENT XXV.—The same experiment (XXIV) was repeated on the left.

The result was the same as that in Experiment XXIV.

EXPERIMENT XXVI.—The left foot was turned outward, seemingly producing an external luxation at the ankle-joint.

An epiphyseal separation was found at the lower end of the tibia.

EXPERIMENT XXVII.—The right foot was turned inward, producing an internal luxation.

Examination showed luxation of the foot inward and sprain-fractures involving the external malleolus and the external articular border of the astragalus.

EXPERIMENT XXVIII.—The left lower extremity was bent at the knee by pulling the leg and thigh outward and pressing the joint inward.

Thus a separation of the lower epiphysis from the femur and a pulling away of bony tissue from the external condyle were produced.

EXPERIMENT XXIX.—The right leg was bent to either side on the femur.

Examination showed a separation of the lower epiphysis from the femur.

EXPERIMENT XXX.—After making the pelvis fast, an anterior luxation of the left hip-joint was produced by carrying the femur through the motions described by Allis as producing anterior luxation of the hip-joint.

Dissection showed luxation of the head, separation of the upper epiphysis from the femur, fractures of both trochanters, and sprain-fractures of the head of the femur (especially at the attachment of the posterior inferior capsular ligament) and of all the bones in this vicinity, from which most of the tendons pulled fragments.

EXPERIMENT XXXI.—The pelvis remaining fixed, the right hip was made the object of a posterior luxation after the description of Allis concerning the way in which it was prone to occur.

Isolation of the structures in the joint region showed posterior luxation of the head of the femur, sprain-fractures of the acetabulum at the attachment of the ligamentum teres and the posterior superior portion of the capsular ligament, sprain-fractures of the bones in this region at the attachments of most of the joint tendons, separation of the epiphysis from the greater trochanter, and a pulling from the bone of all the periosteum from the level of the trochanters up.

EXPERIMENT XXXII.—The left elbow was bent laterally so that the lower humerus and the upper radius and ulna went inward.

Subluxation was produced, and at the sites of attachment of the orbicular ligament to the anterior ulna, the anterior capsular ligament to the radius, and the external lateral ligament to the humerus, sprain-fractures were found.

EXPERIMENT XXXIII.—The right elbow was bent laterally so that the lower humerus and the upper radius and ulna went outward.

Sprain-fracture of the ulna at the posterior attachment of the orbicular ligament and separation of the lower epiphysis from the humerus were found.

EXPERIMENT XXXIV.—Right shoulder-joint.

EXPERIMENT XXXV.—Left shoulder-joint.

EXPERIMENT XXXVI.—Right elbow-joint.

Strain was placed on these joints by twisting; this was persisted in until a crackling was heard, but the integrity of the joints was not disturbed.

Dissection in all three cases showed avulsion of the tendons around the joints from their normal channels.

EXPERIMENT XXXVII (Experiment I).—The skin, ligamentum patella, and all tendon attachments around the left knee-joint were severed. The femur was held in a vice and the leg was grasped with the hand and hyperextended and twisted until the joint was flail-like (subluxated).

Examination showed no gross lesions of the capsule. Further, opening of the joint showed the external lateral ligament partly torn from its attachment to the external condyle of the femur; the tear involved the osseous and not the ligamentous tissue (a sprain-fracture). The tear was due evidently to a lateral twist, as it did not occur in the direction of the course of the ligament.

(The above experiment was done after it was found that weight aggregating 160 to 175 pounds, hung from the tibia, would not make the joint give way.)

EXPERIMENT XXXVIII (Experiment XV).—The left hip was exposed; all of the muscular attachments in this region were cut, leaving the articulation surrounded by its capsule alone. The femur was rotated externally and abducted, producing a luxation.

Examination showed a tear (?) of the weak upper postero-external portion of the capsule and a sprain-fracture at the insertion of the ligamentum teres.

We feel compelled to again refer to Experiments VIII and XII of our previous work on sprain-fracture, as they give admirable demonstration of a stage through which the joint passes before becoming luxated.

EXPERIMENT XXXIX (Experiment VIII).—All skin was removed from the region of the left ankle-joint. All of the tendons passing between points above and below the joint were severed. The tibia was held tightly in a vice. A two-pronged hook was hung from the foot; one prong was hooked around the os calcis, while the other was hooked around

the foot over the anterior tarsal bones; weights were hung on the hook.

Fracture of the calcaneum, involving the surfaces articulating with the astragalus, resulted. No ligamentous tears were found.

EXPERIMENT XL (Experiment XII).—Same as Experiment XXXIX. The hook slipped from its attachment after some pulling force had been brought to bear.

Examination showed that the anterior band of the external lateral ligament of the ankle had pulled away some bony tissue at its point of attachment to the astragalus. No injury to the ligament occurred.

Of these thirty-eight cases, thirteen showed no dislocation; three cases in which an attempt was made to do nothing more than use a straining force, such as if increased would cause dislocation, showed avulsion of the tendons in the joint region (by this we mean a migration of all or parts of the tendons from their normal courses or channels, permitted by a giving way of the tissue binding them to their courses, there being, however, no giving way of tendon fibres); ten cases showed either fracture or epiphyseal separation above or below the joint receiving our attention, two of these showed sprain-fracture in addition, but in neither of these was the integrity of the objective joint distinctly disturbed; seventeen cases showed subluxation, and in all sprain-fractures were demonstrable; further, four of them showed fracture in addition to sprain-fracture; eight cases showed complete luxation with sprain-fractures accompanying; four were also accompanied by gross fracture.

Early in the course of these experiments avulsion of tendons was frequently noted, and Experiments 34, 35, and 36, in which avulsion of tendons alone was noted, were done by applying dislocation-producing force of a mild character. It would seem that avulsion of tendons, by changing the direction of their pull, aids the occurrence of dislocation.

In the ten other cases showing no luxation, fracture occurred, thus preventing the continuation of luxation-producing force and again demonstrating the superiority in tensile strength of the tendons and ligaments over bone. As previously noted, eight of the cases were fracture dislocations or fracture subluxations; though the same condition could have

been and is occasionally produced by direct violence, these fractures, like the ten cases just mentioned, were produced through the agency of ligaments or tendons. Therefore the fractures forming part of the pathology of fracture dislocations are in reality sprain-fractures of enormous dimensions.

The twenty-five dislocation cases, seventeen of which were subluxations, all showed sprain-fracture.

These experiments suggest a mental moving picture of the phases though which the tissues concerned in a subluxation or luxation pass, from the beginning to the termination of the force producing the subluxation or luxation. These phases are: first, strain of the tendons or ligaments (the placing of tension on them); second, avulsion of the tendons and continuation of the strain; third, sprain-fracture or gross fracture, or both, produced through the agency of the ligaments alone, or of the ligaments and tendons; fourth, continuation of the force resulting in subluxation or luxation.

CADAVER EXPERIMENTS.

On taking up this work we were not unmindful of the fact that degeneration, and therefore weakness, especially of the soft tissues, begins immediately following death; however, we appreciated keenly that the cadaver offered larger structures more easily isolated, but, above all things, the same structures that concern us clinically. In addition, we wished to ascertain the seats of sprain-fracture in luxations occurring in human anatomy.

EXPERIMENT XLI.—After firmly fixing the right scapula and chest, the right arm was abducted until there was a giving way; then the arm was shoved toward the shoulder-joint. Thus the cardinal signs of subcoracoid luxation were produced.

Dissection of the joint showed a subcoracoid position of the head of the humerus, a sprain-fracture involving about 4 cm. of the anterior inferior margin of the glenoid fossa, which was pulled away by the capsule here attached, and a separation (visible to the eye) of the fibres of the capsule just above the site of the sprain-fracture (see Fig. 1).

EXPERIMENT XLII.—With the left scapula and chest firmly fixed, the left arm was abducted until most of the resistance offered was overcome;

then the arm was shoved downward, making the head go from the glenoid cavity and thereby producing what was clinically a subglenoid subluxation (an erect luxation).

Dissection revealed the presence of the head of the humerus largely in a subglenoid position. Sprain-fracture of the greater tuberosity of the humerus at the insertion of the supraspinatus muscle was found. At the same site a slight rent of the capsule was found. Otherwise the capsule was undisturbed (see Fig. 2).

The inferior portion of the capsule was severed in dissection.

EXPERIMENT XLIII.—Following the method described by Allis, the pelvis was fixed and a posterior luxation of the right hip was attempted and produced clinically.

Dissection demonstrated a posterior luxation of the head of the femur, sprain-fracture of the head of the femur caused by a pulling of the ligamentum teres from the fovea, and a rent in the anterior and inferior part of the capsule extending from just below the acetabular rim anteriorly around the neck of the femur internally to the attachment of the capsule to the femur posteriorly. It was doubtful as to whether the rent in the capsule was due to a tear or a separation of the fibres; microscopic sections proved that it was a separation of the fibres. The reinforced portions of the capsule were undisturbed.

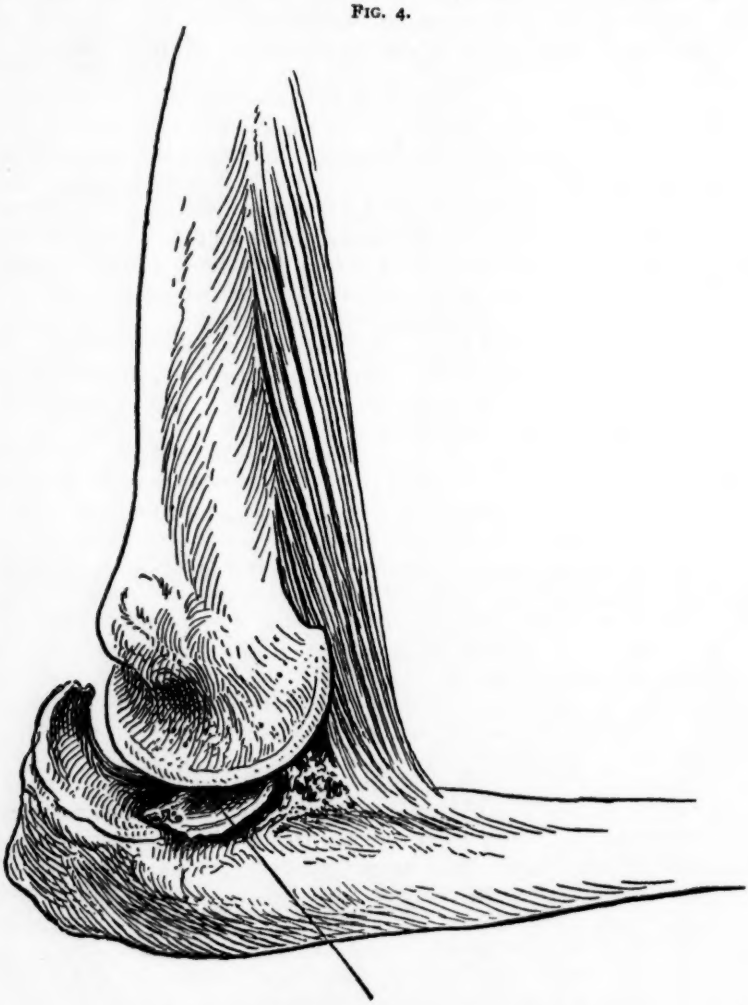
EXPERIMENT XLIV.—An attempt was made to produce an anterior luxation of the left hip according to the description of the mechanism given by Allis. In the attempt it was found impossible to produce more than a subluxation, as the head could not be sent forward from the site of the acetabulum. At the stage of the manipulation where extreme abduction of the leg was attempted it was noted that the left testicle left the scrotum and that there was a distinct dimpling of the skin between the head of the femur and the anterior rim of the acetabulum. Further manipulation revealed the fact that as the head of the femur left the acetabulum the left testis was drawn from the scrotum over into the acetabular cavity, presumably by the vacuum produced when the head left the cavity.

Dissection showed a longitudinal rent in the coverings of the spermatic cord posteriorly and just below the pubic spine, that had permitted the exit of the testis from the scrotum. At the joint, subluxation of the head of the femur, sprain-fractures of the anterior and inferior acetabular rim, sprain-fracture at the anterior edge of the junction of the great trochanter and femur through the agency of the ileofemoral ligament, and separation of the fibres of the pubofemoral ligament were found (see Fig. 3). Those sprain-fractures involving the anterior and inferior portions of the acetabular rim were produced through the agency of the cotyloid and capsular ligaments and seemingly independently. The largest sprain-fracture of the rim was just below the cotyloid notch.

EXPERIMENT XLV.—The lower right humerus was placed under a stationary iron bar, then the arm and forearm, in either hand, were pulled upward until what appeared to be a posterior luxation of the ulna was produced.

Dissection confirmed the posterior position of the ulna. A separation of the fibres of the flexor sublimus digitorum near the internal condyle, sprain-fracture of the internal condyle by some of these fibres and those of the internal lateral ligament, and separation of the fibres of the anterior

FIG. 4.



Effects of experimental subluxation backward at elbow.

capsule, proved by microscopic section, were demonstrated. Part of the orbicular ligament was severed to facilitate exploration of the joint tissues.

EXPERIMENT XLVI.—By the use of the stationary iron bar and the same mechanism as in Experiment XLV, what seemed to be a subluxa-

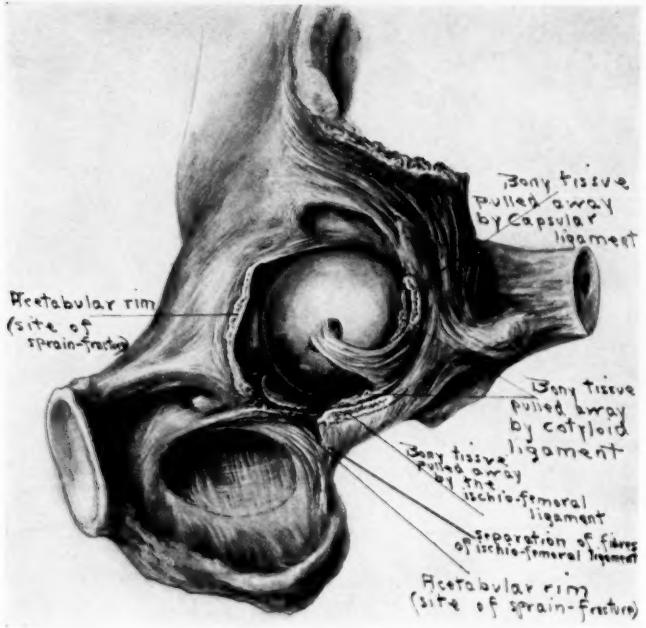
FIG. 1.

Effects of experimental attempt on the cadaver to produce a subcoracoid dislocation at the shoulder.

FIG. 2.

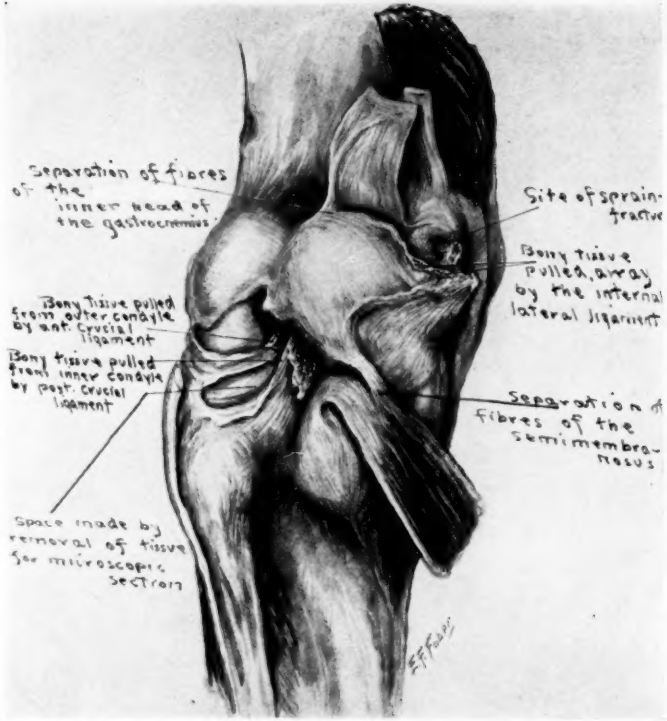
Effects of experimental subglenoid dislocation.

FIG. 3.


Bony tissue pulled away by Capsular ligament
Acetabular rim (site of sprain-fracture)
Bony tissue pulled away by cotyloid ligament
Bony tissue pulled away by the ischio-femoral ligament
Separation of fibres of ischio-femoral ligament
Acetabular rim (site of sprain-fracture)

Effects of experimental attempt on the cadaver to produce an anterior dislocation of the hip-joint.

FIG. 5.


Separation of fibres of the inner head of the gastrocnemius
Site of sprain-fracture
Bony tissue pulled away by the internal lateral ligament
Bony tissue pulled from outer condyle by ant. Crucial ligament
Bony tissue pulled from inner condyle by post. Crucial ligament
Separation of fibres of the semimembranosus
Space made by removal of tissue for microscopic section

Effects of experimental subluxation backward at the knee-joint.

tion of both bones of the left forearm backward from the humerus was produced. The forearm was then forcibly flexed on the arm.

Dissection confirmed the position of the bones of the forearm and showed a horizontal rent in the anterior capsule. A piece of the outer anterior portion of the articulating surface of the ulna (part of the coronoid process), with a good part of the brachialis anticus muscle attached, was jammed backward toward the olecranon by the humerus (see Fig. 4), which in so doing caused crushing of some of the fibres of the brachialis anticus. This was obviously a sprain-fracture by direct violence. The horizontal rent in the anterior capsule extended entirely across the joint; macro- and microscopically, the fibres of the anterior capsule were proved to run horizontally. Therefore the rent in the capsule was due to a separation of fibres, and not a tear. The posterior capsule was torn in dissection for exploring purposes.

EXPERIMENT XLVII.—A subluxation of the right leg on the femur was produced by fixing the femur and pulling the leg outward.

Dissection revealed the presence of a subluxation of the leg externally on the femur, sprain-fracture of the internal condyle of the femur through the agency of the internal lateral ligament, sprain-fracture of the inner tuberosity of the tibia through the agency of the anterior crucial ligament, sprain-fracture of the inner condyle of the femur through the agency of the posterior crucial ligament, two rents in the internal aponeurotic expansion of the quadriceps extensor approaching each other at an acute angle and produced by an easily demonstrable separation of the fibres of the aponeurosis, rupture of some of the fibres of the aponeurosis at the point where the rents in it were nearest each other, and some separation of the fibres of the posterior capsule where the semimembranosus joined it. In the posterior capsule an opening was made in dissecting.

EXPERIMENT XLVIII.—By fixing the left femur and jerking the leg upward, a subluxation of the leg posteriorly on the femur was produced.

Dissection demonstrated the posterior subluxation of the leg, sprain-fracture of the inner and outer condyles through the agency of the posterior and anterior crucial ligaments respectively, sprain-fracture of the inner condyle through the agency of the internal lateral ligament, sprain-fracture of the posterior tibia between the tubercles, through the agency of the posterior capsule, separation of the fibres of the posterior capsule, proved by microscopic section, separation of the fibres of the semimembranosus at the seat of its expansion into the posterior capsule, and separation of some of the fibres of the inner head of the gastrocnemius. The two last-mentioned fibre separations were clearly visible to the unaided eye (see Fig. 5).

EXPERIMENT XLIX.—The right hand was bent (the arm being fixed) in all directions until a giving way was felt.

Dissection showed a slight subluxation of the fourth and fifth metacarpals on the uncinate bone, sprain-fracture of the hook-like process of the uncinate bone, sprain-fracture of the uncinate bone posteriorly at the articulation of the fourth and fifth metacarpals with the bone, and a diagonal fracture of the radius extending from without inward and down-

ward into the radio-ulnar articulation. The capsule at the articulation of the third metacarpal with the carpal bones was cut in attempting to demonstrate the bone lesions.

EXPERIMENT L.—This experiment was carried out on the left wrist in the same way as Experiment XLIX.

Dissection showed subluxation of the wrist-joint and sprain-fracture of the styloid process of the radius.

EXPERIMENT LI.—Holding the left leg in a vice, the foot, grasped at the toes, was turned inward until a giving way was detected.

Dissection showed a slight subluxation involving the articulation of the calcaneum with the cuboid and cuneiform bones, and sprain-fractures involving the superior articular surfaces of the anterior calcaneum, the cuboid, and the cuneiform bones. An opening in the external portion of the capsule uniting the calcaneum and astragalus was made to get additional exposure.

EXPERIMENT LII.—With the right leg held in a vice, the foot was bent outward, producing what was apparently a subluxation of the ankle-joint.

Dissection confirmed the presence of subluxation of the ankle-joint and showed the following sprain-fractures: the external malleolus, the internal malleolus, and the external articulating surface of the astragalus.

EXPERIMENTS LIII and LIV.—After a hand had been kept for one month, part of which time it was in cold storage and part of which time no particular attempt was made to preserve it, the middle phalanges of two fingers were luxated on their proximal phalanges by bending them backward on the proximal phalanges.

Dissection confirmed the presence of the luxations, but in neither instance gave distinct evidence of sprain-fracture, though there was slight roughening of the bones. Both anterior capsules were opened horizontally. Microscopic sections of the capsules showed these openings to be separations of fibres. The dislocations were complete.

In these experiments, as in those on dogs, quickly and slowly applied force was used, sprain-fracture resulting consistently wherever luxation occurred. Luxation or subluxation was produced in every one of the fourteen cadaver experiments; twelve of these experiments showed the production of sprain-fractures. In the two cases showing no sprain-fractures complete luxation was permitted through a separation of the fibres of the capsule. In these two cases abundant opportunity had been given for advanced degeneration of the softer tissues. Separation of the fibres of the capsule was encountered in nine cases (five were complete dislocations and four were subluxations). Where any doubt existed as to the direction in which the fibres ran, microscopic sections were made. These experi-

ments have shown that, with a certain amount of capsular relaxation, dislocation permitted by separation of the fibres of the capsule of the joint is a mechanical possibility, without the occurrence of sprain-fracture. Yet separation of the fibres of the capsule alone has been a rare occurrence, in our experience, seen only when tissue degeneration was present. Allis, in referring to the injuries to the ligaments of the hip joint in dislocation, noted that the ligamentum teres was usually torn from the head of the femur and that the capsule showed one of three conditions: tear from its acetabular or pelvic insertion (sometimes bringing periosteum with it), tear from its femoral attachment, and rent either between the attachments or running from one attachment to the other. From his descriptions we infer that the tears from the bone must have been sprain-fractures of small size and that the rents in the capsule must have been permitted by separation of the capsule fibres, as was the case in Experiment XLIII. It has been demonstrated to us in our work that separation of fibres takes place readily following a sprain-fracture that permits of abnormal motion of the elements of a joint. We have also found that occasionally the continuation of a force that first produces sprain-fracture may terminate with rupture of the fibres of the ligament or tendon involved, as in Hawkes's [3] case.

Though amazed at finding sprain-fracture so constantly in this cadaver work, for we had reckoned that degeneration of the soft parts would permit of no comparison of the relative strengths of bone and tendinous or ligamentous tissues, we were impressed with the fact that, though some degeneration of the soft tissues must have occurred at the time of the experiments, the relatively greater strength of them over bony tissue discounted this degeneration and permitted our results.

Knowing that Maisonneuve, about a century ago, in a memoir, described sprain-fractures of the external and internal malleoli and sprain-fracture of the styloid of the ulna in Colles's fracture of the radius, the fact that many men producing luxations in cadavers have not observed the occurrence of sprain-fracture recalls these points: first, sprain-fractures

are often so minute as to be barely visible to the eye, though easily palpated; second, extensive exploration of the joint cavities and surrounding tissues is often necessary before sprain-fracture can be demonstrated; third, advanced degeneration of soft tissues will not permit of the production of sprain-fracture; cadaver work, therefore, will not permit the drawing of comparisons as to the frequency of sprain-fracture in dislocation.

Thomas,[4] in speaking of his work on shoulder luxations, says: "I recall one cadaver specimen in which, in addition to the usual anterior capsule tear, there was an opening into the joint posteriorly, due to the tearing off of the greater tuberosity by the attached supra-spinatus and infra-spinatus and the underlying capsule. In connection with the earlier specimens, such a condition did not particularly interest me, but, so far as I can recall, this was the only one in which such a tearing off of bone was observed."

We find another group of observers who, when working on joints, have noted what we now believe must have been sprain-fractures, but they have been unable to offer tangible explanations of their findings. R. W. Smith,[5] in his work on luxations published in 1854, in speaking of an old case of fracture of the greater tuberosity of the humerus with subcoracoid luxation of the head, said, "The capsule had not been injured, but was thickened and enlarged, and bone had been deposited in its tissue." This so-called deposition of bone must have been an old sprain-fracture around which the tissues had united.

Marsh,[6] in 1868, reported a description in the Museum of the College of Surgeons Catalogue which read: "A knee-joint in which there are two small growths of apparently cartilaginous and osseous substance. The largest of them, attached to the crucial ligaments, has an oval outline, measures nearly an inch in its greatest diameter, is flat on its lower and very convex on its upper surface. By friction and constant pressure it had worn for itself a deep cavity, with hard grooved walls, in the posterior and lower part of the outer con-

dyle of the femur, in which it lay imbedded and apparently immovable. The second presents nodules of cartilage on its surface, is fixed to the synovial membrane just below the patella. The encrusting cartilage in this joint is much worn away, and the surface left by its removal is eburnated; but there does not appear to have been any inflammatory action as the result of the constant irritation which the pendulous cartilage must have produced." The first-named piece of osseo-cartilaginous tissue quite likely was the result of sprain-fracture; for we have found sprain-fractures, through the agency of the crucial ligaments, to be present fairly constantly in knee luxations, and, though no mention of luxation was made in this case, we know that spontaneous reduction of dislocations frequently takes place in joints similar in construction to the knee-joint. The second-named piece of tissue, along with some loose osseo-cartilaginous bodies in joints, described by Marsh and Brodie,[7] may or may not have been the result of sprain-fracture, though it seems quite likely that the bony tissue may have wandered from the ligaments producing the lesions, with the choice of becoming reattached elsewhere.

A third group of men has noted sprain-fracture in association with luxations. In 1847, Gibout,[8] Deville, and Malgaigne described what we now call sprain-fractures, and called them "fractures by tearing." Callender,[9] in 1866, reported a case of wrist-fracture. Part of his description reads, "The proximal portion of the shaft was also displaced upwards, carrying with it the ulna, the latter bone being torn away from its triangular ligament, to which the tip of the styloid process remained attached." Francke, Hildebrand, Kraske,[10] Sick,[11] and Sculler [12] all reported cases of anterior luxation of the shoulder-joint in which sprain-fractures involving the glenoid cavity were found; most of these involved the anterior margin of the glenoid cavity.

Joessel [13] described a tearing of the tendons of the supra-spinatus and infra-spinatus muscles from the greater tuberosity of the humerus, thereby causing a roughening, as the

chief predisposing cause of recurrences of anterior luxations of the shoulder.

Thomas [14] recently said: "Whenever there is a fracture of the greater tuberosity of the humerus there has been a dislocation of the shoulder, and in those cases in which there is no history of a dislocation the latter did occur at the moment of forced abduction, but was spontaneously reduced, as the arm fell to the side of the body immediately afterward."

DISLOCATION FROM THE X-RAY VIEWPOINT.

In consulting the X-ray records of the German Hospital for the years 1909, 1910 and 1911, and the first three months of 1912, made available through the courtesy of Dr. A. G. Miller, skiagrapher to the hospital, we found that 92 luxations had been skiagraphed. Thirty-one, or about thirty-four per cent., showed fracture; three of the thirty-one fractures, or about three per cent. of the ninety-two cases, were sprain-fractures; the twenty-eight remaining cases, about thirty per cent. of the total number, were fracture dislocations.

Of the ninety-two luxations, all but twenty-six were taken in but one plane; these twenty-six cases were taken in two planes; eleven, or about forty-two per cent. of them, showed the occurrence of fracture or sprain-fracture.

Many luxations are not properly studied, for two reasons: first, because of spontaneous reduction; second, because the surgeon who has reduced the luxation has failed to report the fact to the skiagrapher. So it is apparent that a consideration of all luxations is impossible, but consideration from the skiagrapher's findings gives the nearest approach to accuracy. We have perhaps sacrificed more striking conclusions concerning sprain-fracture by including among the others the congenital luxations, which, as we know, have uncertain etiology and primarily concern cartilaginous tissue. However, the ninety-two cases afford opportunity for making some very interesting observations. The fact that twenty-eight, or about thirty per cent. of these luxations, showed fracture is significant. Many of us had looked upon gross fracture in association with

luxation as a much more rare occurrence. Yet these fractures are really the result of the tendons and ligaments pulling off bigger bites than are pulled off when we diagnose sprain-fracture. However, it is easily understood; for are not all fractures, whether they be sprain-fractures in association with luxations, or uncomplicated fractures, if caused by indirect violence, permitted on account of the fact that tendons and ligaments retain their integrity longer in time of stress than bone? These things being true, we must consider these fractures occurring with luxations to be sprain-fractures of great degree, or, better, sprain-fractures and more; going beyond the mere occurrence of sprain-fracture.

Since it would be unlikely for fracture to occur following dislocation, unless by direct violence, we consider that the thirty-one cases of luxation showing fracture or sprain-fracture were permitted to occur by the primary occurrence of fracture or sprain-fracture.

Bissell evolved a theory as to the probable causation of fracture in association with dislocation; namely, that the bone was fractured by the force used in trying to reduce the dislocation. He reasoned: if luxation occurs first, how is there force enough left to cause fracture?—and if fracture occurs first, how is it possible for there to remain leverage enough to luxate the joint surfaces?

We believe the primary occurrence of fracture permits sufficient giving way of the capsule to allow easy separation of the joint surfaces with the use of little or no leverage. Further, our X-ray pictures have shown fractures before reduction was attempted.

It is interesting to find that Allis, in speaking of a fracture dislocation, said: "The fracture occurred prior to the dislocation. It could not have taken place after it; in other words, the dislocation was the result of the fracture."

Why have approximately sixty-six per cent. of these cases failed to show evidence of sprain-fracture or fracture, if we would substantiate our experimental findings? We know that sprain-fractures comprise about fifteen per cent. of all

fractures, but here, being three in thirty-one, they comprise but about eleven per cent. of the fractures. These figures show a discrepancy of four per cent., but our belief (for we believe sprain-fracture occurred in all of the cases that did not show gross fracture) makes the discrepancy eighty-nine per cent. In this series of cases exposure was not made in a number of planes sufficient to convince us that sprain-fracture or fracture had not occurred. Gross fractures are, as a rule, easy of demonstration by X-ray, and exposure in one plane is often sufficient for the demonstration. On the other hand, it is most often the case that sprain-fracture cannot be demonstrated unless the X-ray picture is taken in a plane that is on the line of a tangent to the circumference of the bone, originating from the site of the lesion, with nothing intervening (Ross and Stewart). This would, of course, necessitate, at times, many exposures, in order that the right plane might be gotten. On the twenty-six cases that exposures were taken in two planes encouraging results were encountered, for eleven, or about forty-two per cent. of them, in contradistinction to twenty, or about thirty per cent., of the remaining (or one-exposure) cases, showed fracture. We must remember at the same time that many sprain-fractures are too minute for X-ray demonstration.

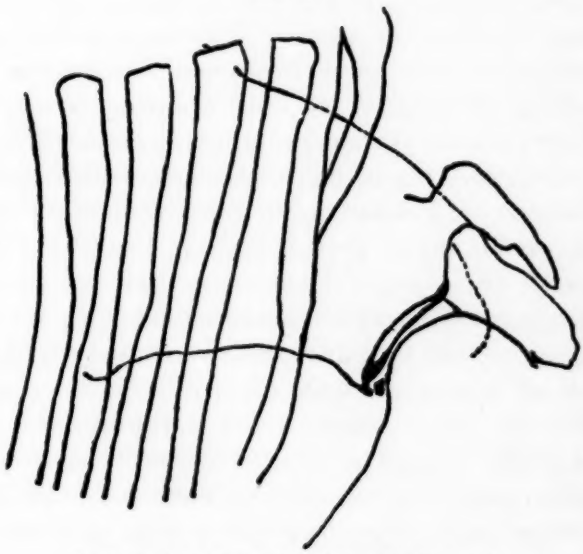
As a result of the study of these cases we concluded that there were two, and possibly three, reasons why all of the cases did not show sprain-fracture or gross fracture on the X-ray plate: first, the plates did not happen to be taken in a plane that would permit of the demonstration of the presence of sprain-fracture or gross fracture; second, in some few cases the sprain-fractures may have been so small that they could not be demonstrated by X-ray plates; third, it is possible that in rare instances luxation might have been permitted by a separation of the fibres of the joint capsule.

DISLOCATIONS FROM THE CLINICAL VIEWPOINT.

In the luxations encountered by us since drawing these conclusions, we have persistently skiagraphed the involved

joints in different planes and have in them all been rewarded by the demonstration of sprain-fracture or fracture. Though the number of cases so far observed is too small to be of value for detailed presentation, we cannot refrain from citing one of the most interesting of them.

FIG. 6.



Sprain-fracture of anterior inferior glenoid margin.

A. A. was admitted to the Germantown Hospital following an injury to the left shoulder. X-ray (2/5/1912), one exposure, showed a subluxation. Five more exposures in different planes were made (2/9/1912). One of these showed distinctly a sprain-fracture of the anterior inferior glenoid margin (see Fig. 6). Several of the other plates showed a sprain-fracture of the greater tuberosity of the humerus. The use of these plates was made possible by the courtesy of Dr. Paul Austin, skiagrapher to the Germantown Hospital.

The clinical diagnosis of luxation commands no attention here; the clinical diagnosis of sprain-fracture in connection with dislocation, made easier by first reducing the dislocation, is reached in the same way as is the clinical diagnosis of

sprain-fracture alone; furthermore, as is the case with sprain-fractures alone, sprain-fracture occurring in dislocation can be diagnosed without X-ray findings.

PRACTICAL CONSIDERATIONS.

To revert to the discussion of the X-ray findings in the ninety-two cases of luxation, one of these was a luxation of the femur showing an excess of callus around the head and neck, and another was an old luxation of the humerus upward and forward showing an old osteo-arthritis. We have been led to believe, from our studies in these cases showing osteo-arthritis and covering of the joint surfaces with osseous tissue, following old dislocations, that the origin of the new bone formation is the site of a sprain-fracture that had occurred at the time of the injury. Furthermore, we believe that the softer tissues of different consistency, found on joint surfaces exposed but a short time after dislocation, and covering them in whole or in part, are quite often in some stage of transformation into bony tissue, which transformation is being brought about by the advancement of osteoblasts from a site of sprain-fracture. Knowledge of these possibilities should attract more attention to the proper treatment of these cases when they are new, for such conditions as bony ankylosis can be avoided. However, when neglected cases become old this same knowledge should be of service in searching the joint surfaces for lesions that would give ideas concerning treatment and prognosis.

The great difficulty of demonstrating sprain-fracture without complete exposure of a joint was constantly demonstrated in our dissections. In operative procedures free dissection most often is not practical, and many sprain-fractures, no doubt, escape the detection of operators. Study of a very large number of cases from the clinical, the experimental, and the X-ray viewpoint would give us information in reference to the most frequent site of sprain-fractures in certain dislocations of each joint that the number of cases here studied does not afford. A study of this sort would enable the surgeon in

the non-operative treatment of dislocations to place the injured parts in position favorable to union of the severed bones, and it would enable the operator to expose his joints at the most frequent sites of sprain-fracture, providing their senses and X-rays gave them no information. We lay emphasis on the statement already made that X-ray does not demonstrate all sprain-fractures, and add that all dislocations should be treated as if sprain-fracture had occurred, meaning that a luxation should be at rest absolutely for three weeks following reduction, dressed in a position favoring reposition of fragments; in other words, it should be accorded the same treatment as fracture dislocations. We believe in reference to most recurrent luxations of all joints the same as Joessel believed in reference to recurrent anterior shoulder dislocations; namely, that they are permitted by the non-union of sprain-fractures. However, union in faulty position may permit the same occurrence. Therefore, we consider it rational, where operative procedure is undertaken in these cases, to approach the site of sprain-fracture and repair it with either catgut or phosphor-bronze wire, as recommended by Murphy [15] for fastening tendons to bones. This applies to cases where but little bone is pulled away. Where there is pulling away of bone of sufficient size, the use of ivory screws, as suggested by Magnuson [16] in his work on the lengthening of bones of the leg or the use of wire nails, is indicated for repair of the sprain-fracture. Ivory screws used in experimental bone work by Dr. Stewart have been most satisfactory, being capable of withstanding great strain and having the additional advantage of being absorbed. This form of procedure is not indicated in all luxations coming to operation; in a posterior luxation of the head of the radius recently operated on by Dr. Ross small pieces of bone, probably the result of sprain-fracture, were demonstrated, a fragment of the head of the radius was removed, and a transverse fracture of the olecranon was wired; no attempt was made at further exploration to verify the presence of sprain-fracture with a view of repairing it, as it was found that the above-described procedure, including suture of the

capsule where incised, seemed to be sufficient to maintain the joint's integrity. Moreover, operation for recurrent dislocation is often made successful by taking a reef in an enlarged capsule or by suturing together separated capsular fibres.

It is interesting to note that Thomas, in quoting the statement of Stimson that "clinically it is known that after a few days or weeks marked by gradually diminishing tenderness and swelling the joint can be freely used without pain," says, "It is obvious that when a joint can be freely used in a few days without pain there is no fracture." Our experience has been that a large proportion of sprain-fractures cause no pain on free use of the joint within a few days after the injury, but, if not properly treated, pain on use of the joint appears after sufficient time has elapsed for the development of arthritis or excessive callus.

CONCLUSIONS.

1. Practically all, if not all, dislocations are permitted by the primary occurrence of strain of tendons and ligaments, followed by avulsion of tendons, and then sprain-fracture or gross fracture.

2. It is possible that some dislocations are permitted to occur by separation of the fibres of the capsule in place of by sprain-fracture or gross fracture.

3. All dislocations should be skiagraphed and, if evidence of fracture is not found at first, pictures should be taken in many planes.

4. All dislocations should be treated as if fracture had occurred, even in the event of negative X-ray evidence.

5. Some sprain-fractures are too small to be shown by X-ray pictures.

6. Often there is spontaneous reduction of dislocations, and sprain-fracture or gross fracture is the only evidence left that can be detected by X-ray.

7. The sites of sprain-fractures or gross fractures provide the foci from which the osteoblasts issue, in those cases showing excessive callus or covering of joint surfaces with osseous tissue; moreover, the softer tissues found in joint cavities

within a short time after the occurrence of dislocations are often in some stage of transformation into bony tissue.

8. Sprain-fracture or fractures occurring consistently in experimental dislocations on cadavers afford the most positive proof of the fact that dislocations are permitted to occur in this way; but failure to demonstrate sprain-fractures or fractures consistently in experimental dislocations on cadavers means nothing, since the stage to which degeneration has advanced determines whether the greater tensile strength remains in the tendons and ligaments or not.

9. Whether the force be suddenly or slowly applied, sprain-fracture or fracture precedes the occurrence of practically all, if not all, dislocations.

Finally, we wish to acknowledge our indebtedness to Dr. J. E. Sweet, who placed the facilities of the Laboratories of Surgical Research of the University of Pennsylvania at our disposal.

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THE TREATMENT OF INTRACAPSULAR FRACTURES OF THE HIP.*

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In spite of the amount of attention which has been bestowed on this subject we still come across cases of ununited intracapsular fractures of the hip in patients totally disabled who are otherwise in good health. This is evidence that the treatment to which they were subjected was inefficient. Most of these cases which have come under my notice have been treated as is not unusual with fractures of the shaft of the femur, that is, by longitudinal weight traction and sand bags. I am thoroughly convinced of the utter inefficiency of this method of treatment, and think it time for the profession generally to recognize that such is the case. In the aged, at times, it is justifiable to ignore attempts at union in order to preserve life, but in many cases, even though advanced in years, we can make some effort to obtain better local results. Of all the methods suggested for the treatment of recent fractures I am most partial to that originally suggested by Phillips and later by Maxwell and advocated by Ruth of Iowa, many years ago. It consists of the usual longitudinal traction with weights and sand bags or other device to hold the foot vertical, supplemented by lateral traction by a weight over the side of the bed, drawing the upper portion of the thigh out. I have also obtained good results by the use of plaster of Paris, putting the limb up in extreme abduction as advised by Whitman in cases of children. Of these two methods the lateral traction is the one usually easier to apply and carry out, and as it is efficient I prefer it.

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* Read before the Philadelphia Academy of Surgery, May 6, 1912.

In regard to ununited intracapsular fractures of the hip there are of course many cases in old people abroad in the community, but they do not seem to be the ones clamoring for treatment. These patients are naturally not very active and are probably warned that their condition is hopeless and hence accept the inevitable with resignation. There is a younger set, however, all the way from comparatively young adults up to fifty-five or sixty years of age, who come to our hospitals and apply for relief, usually using crutches and practically totally disabled. They usually apply from about four or five months to a year and a half after the injury. In the *University Medical Magazine,* September, 1900, I reported two cases in which I had operated on two such cases, using in one steel pins to hold the fragments together and in the other ivory pegs. In a subsequent article in the *American Journal of Orthopædic Surgery* of February, 1909, I briefly reported the use of steel screws to pin the fragments in three cases, but the main object of the paper was to show that satisfactory results could be obtained by freshening the ends of the fragments and keeping them in contact by placing the limb in forced abduction encased in plaster of Paris. Three additional cases were reported illustrative of this method of treatment, in which no foreign bodies were used for fixing the fragments in position.

Finally, the idea suggested itself that if it is possible to dispense with the use of fixation by the insertion of nails, screws, etc., it might also be possible to secure a sufficient amount of fixation and support of the part by persistently fixing it in an abducted position and allowing the patient to walk on it without doing any open operation at all.

Occasionally a case will present itself in which operation for one reason or another is not advisable; therefore it is in the highest degree desirable to know what can be done for these cases by non-operative measures. To obtain any reliable information on this point, cases must be followed for a long time, which is usually a matter of considerable difficulty. The following experiences are submitted. Skiagraphs were made of nearly all of them.

CASE I.—A man aged thirty-seven applied for treatment with an ununited intracapsular fracture of the femur of nine months' standing. It had resulted from a fall or other violence and had been treated with rest in bed for five weeks, after which he got up and around on crutches. On admission to the hospital he had about 1½ inches shortening, his greater trochanter could be felt sliding up and down when weight was put on it; he had marked eversion of the foot, grating on motion, considerable pain, and was only able to get around with crutches.

Treatment.—For a week he was put in bed with weight extension with the limb in an abducted position. Good abduction having been obtained, the limb was placed in marked abduction and a plaster-of-Paris cast applied from the waist to the toes. Four days later he was gotten out of bed and left to go around with a crutch and cane. The plaster-of-Paris cast was kept on for six or eight weeks, and then an abduction splint was substituted for it.

The amelioration of symptoms was marked from the start. At first he used crutches, but soon discarded these for a cane, which he has continued to use since.

When he started to walk he felt the fragments move in the hip, but that has ceased and he feels no movement when walking, but still can feel it a little when he makes an unusual or side step. His latest communication, nearly two years after commencing treatment, stated that his leg was getting less painful and that he was still improving. He can walk as much as three miles at a time. The shortening remains as at first, the position of the foot is natural. Flexion and extension are perfect, abduction limited, and rotation somewhat limited.

This man has nearly as good a result as if he had been operated on, but not quite, and operation would probably have saved him a good bit of time and considerable pain. This man has a lawsuit on hand, a fact which is liable to make these patients pessimistic.

CASE II.—The patient was a man aged forty-six. His fracture was of five months' standing. He complained of constant pain, marked disability, walked with crutches, shortening one inch, and not very much movement of the fragments.

Treatment.—A plaster cast was applied and worn for six weeks. The pain in the hip disappeared, but he had pain in the knee, which still remained after five months.

This man is walking around now, about two years after the injury, with a cane. He still complains of pain in the knee and he is not working and is not looking for work. No motion is perceptible in the hip.

This case resulted in the man being permanently disabled, that is, he is not earning his living. He looks like a tramp and, as is not uncommon, he may have seized on his injury as an excuse for loafing.

CASE III.—A man aged forty-eight years was treated for the original injury in a hospital with longitudinal extension and sand bags. Injury occurred eight months previously and on application for treatment walks only with crutches, has difficulty in going up and down stairs. Hip feels weak and gives way. There is considerable movement to be felt when he puts his weight on the limb and there is shortening of an inch or more. Pain severe, especially at night, and cannot lie on the affected side.

Treatment.—He was treated with a plaster cast and the limb placed in abduction for four months and then an abduction splint was applied. The splint did not please him and he never wore it. It is now two years since the injury and he has no pain. He says the hip does not slip, but on putting one's hand on the hip and having him bear his weight on it, it does seem to slip somewhat. He says he can walk all day with a cane and could go to work, but he cannot find any. He desires to tend horses and work in a stable. He says his hip is getting stronger all the time.

This man will be probably all right in a few more months.

CASE IV.—A man aged fifty-two. Treated for the original injury by straight extension and sand bags. He complained of bad pain in his right hip, loss of power, and there was movement and shortening. The time which had elapsed since the accident was not stated.

Treatment.—He was put up in plaster, the limb being markedly abducted. The cast was worn for about two months and then replaced with a brace. Improvement was prompt and satis-

factory from the start and seven weeks after the cast was first applied he could walk 20 squares (two miles), using only a cane. Now two years after first applying for treatment he can walk practically all day. He carries a cane and limps. He has been a watchman and janitor in a club, going up and down four flights of stairs. The hip does not slip. He wears no brace, but he says he sometimes has a pain in the thigh when he gets in a cramped position. This is a good result.

CASE V.—Man, aged fifty. He was treated for the original injury six weeks in a hospital and then laid up home for four weeks more. Since going around (not stated how long) he uses two crutches, and while he could go two miles just allowing the toes to touch the ground, still he had so much pain anteriorly down the thigh and knee that he applied for treatment. The hip was very insecure and very painful.

Treatment.—He was put to bed and weight extension with the limb in abduction was applied for four weeks. A plaster cast was then applied and in seven weeks he was walking about the ward without crutches and only complained of a little pain posteriorly. A brace was then fitted and he left the hospital, discontinuing treatment. This man had a lawsuit on hand and it appeared as if he thought he was getting well so quickly that it would prejudice his case before a jury, so he kept away and declined further treatment.

CASE VI.—Woman, about forty-eight years of age, was treated for the original injury in a hospital for a fractured nerve (?) with sand bags only, no weights. When she came under treatment 10 months after the injury, pain was constant and very severe. She used crutches.

Treatment.—She was treated as an out-patient and the hip put up in abduction in plaster of Paris for nine weeks and after that an abduction splint applied. She improved very markedly for a time, and finally used only one cane, but still complained of pain.

At present, one year and nine months after first seen, she is still going around on one cane and complaining so much of pain that she wishes to be operated on.

Unfortunately this patient is addicted to the use of liquor and it is questionable as to what extent her bad habits are influencing her general condition. She has apparently changed her mind

about having the operation because she has failed to avail herself of an opportunity to enter the hospital for treatment.

CASE VII.—Man aged sixty-five years. On entering on a term of service in one of our hospitals this patient was found helplessly bedridden for months with an ununited intracapsular fracture of the hip.

Treatment.—He was put up in plaster of Paris with the limb abducted, and in two months he was up and walking about.

CASE VIII.—Man aged forty-one years was hurt by being thrown from a wagon. His treatment is unknown. Three months later there was non-union. He lay on a lounge five months longer and then began walking around with a cane. Four months later, or a little over a year from the time of the accident, he began to do a little work and has worked steadily since a year and seven months after the accident. He is a driver and can go on and off his wagon without trouble.

This was a case probably of fracture low down toward the trochanters and after a year's time firm union occurred.

Since my attention was first directed to these cases of intracapsular fracture of the hip, with regard especially to the question of serviceable union, I have operated and reported on about five cases in which screws, pins, etc., were used for fixation; on three cases in which the edges of the fragments were freshened by open operation and the limb then treated in abduction with a plaster splint; and now submit eight cases in which no operation whatever was done, most of which have been under observation for about two years. Other cases have come under my care, mainly recent ones, in which the fragments have either been fastened with a screw or the cases treated conservatively by means of the combined lateral and longitudinal traction or by fixing the limb in forced abduction by means of a plaster-of-Paris cast. From these and other experiences we feel justified in concluding as follows:

1. Fracture of the neck of the femur in children is best treated by putting the limb up in plaster in the abducted position as suggested by Whitman. Success will almost certainly

be achieved by this method. A lack of treatment is usually followed by union with a certain amount of shortening, limp, and coxa vara.

2. Fracture of the neck of the femur is not a rare injury in young adults or in those whose bones have not weakened with age.

3. In these otherwise healthy adults, say up to fifty-five years, treatment of the injury by longitudinal traction alone will not infrequently result in loose and disabling non-union, often with severe pain, for a year and a half or longer.

4. Treatment in this same class of cases by longitudinal combined with lateral traction or by putting them up in wide abduction in plaster of Paris will usually result in sufficient fixation to give a useful and serviceable limb.

5. Of the two methods of treatment, that by longitudinal and lateral traction is by far the easier to apply and is more suitable the older the patient. For the plaster cast to be efficient requires great skill in its application and is better adapted to the younger patients.

6. In those cases in which the fracture runs down toward the trochanters, firm union and fixation may take place after a period of disability lasting more than a year.

7. The surest way of remedying cases of ununited fracture of the neck of the femur is to cut down, freshen the edges of the fragments, pin them together with screws, nails, or other means, and put them up in the abducted position.

8. When foreign bodies are inserted to pin the fragments together they are likely to cause discomfort sufficient to necessitate their removal. Considerable discomfort follows the operation and the patient is inclined to attribute this to the nail or screw and demand its removal.

9. Firm union can be obtained by freshening the surfaces of the fragments and then jamming them together by widely abducting the limb and fixing it in plaster of Paris without the use of any nails, screws, or other fixation appliances.

10. Convalescence, even after operations, may be prolonged

and it may even be a year before good use of the limb is obtained; at all events its condition continues to improve for a long time.

11. If no operation is done non-union results in total disability, necessitating the use of crutches for a long time. The pain is often distressing and the hip insecure. Even these cases tend to improve and ultimately the pain may disappear and locomotion be fairly satisfactory.

12. In cases in which operation for one reason or another is inadvisable, much relief can be given by conservative measures and it is well worth while to institute them.

13. The best means of treatment by conservative measures is to fix the affected limb in a position of wide abduction by means of a plaster-of-Paris cast extending from the waist to the toes.

14. This abduction is to be obtained either under general anæsthesia or by weight extension with the limb in an abducted position, which is increased to its limit while the patient is confined to bed for a week or two.

15. The immediate result of the application of the cast is to cause a marked lessening of the pain and increased comfort in locomotion.

16. A persistent use of the plaster bandage gives the greatest relief and causes the quickest fixation.

17. When, for any reason, the use of the plaster-of-Paris bandage is undesirable, then it may be substituted by a brace, which, however, is usually not so efficient as is the plaster of Paris.

18. Persistent use of non-operative conservative measures may be roughly estimated to give after the lapse of two years about 40 per cent. of cases with firm, painless hips. Another 40 per cent. will be very much improved and may or may not earn their living, according to their industry, their habits, and their surroundings. Twenty per cent. will probably remain so much disabled as to be unwilling to work even though pain may not be great. They will usually walk with a cane.

19. The treatment by operation either with or without

fixing of the fragments by screws, nails, etc., according to the wishes of the surgeon, results in quicker and better healing than by non-operative means.

20. In the aged many cases are of necessity to be treated with a view solely to maintaining life.

21. In not a few aged cases the vitality is such as to justify an attempt to give a serviceable limb. In these cases the combined longitudinal and lateral traction is usually the method of choice, although under exceptionable circumstances, such as abundant skilful aid and sufficient facilities, fixation in the abducted position in plaster of Paris may also be used.

TREATMENT OF DISLOCATION OF THE HEAD OF THE RADIUS COMPLICATED BY FRACTURE OF THE ULNA.*

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In small children so-called subluxation of the head of the radius ("pulled elbow") occurs not infrequently, usually from vertical traction on the forearm, as the child's care-taker helps or lifts him across an obstruction in the street. If the forearm is in supination this vertical traction tends to bring the forearm and arm into a straight line, causing momentary loss of the carrying angle; or forced pronation may pry the radius forward over the ulna as a fulcrum. Strong contraction of the biceps, on the child's part, no doubt aids materially in causing the displacement. The pathology of these slight injuries is not very definite; but the disability is quickly relieved by full supination of the forearm, followed by direct backward and inward pressure on the displaced head of the radius. The explanation of Duverney (1751), that the head of the radius is drawn downward and caught in the orbicular ligament, is accepted by Stimson as the most satisfactory of the numerous explanations which have been suggested; but at the risk of adding a new theory to many that are unsatisfactory, it has occurred to me that a very simple explanation may be that the head of the radius merely is "decentered," so to speak, on the capitellum of the humerus, and is held in this malposition by muscular spasm or ligamentous tension. Such an idea is expressed, but not very definitely, by Malgaigne. The deformity is scarcely appreciable, and the disability is so very easily corrected and has in some cases corrected itself with such facility, that it seems hard to accept a definite rupture of ligaments as a cause.

* Read before the Philadelphia Academy of Surgery, May 6, 1912.

Moreover, recurrence of the condition is not unusual, without recognizable trauma.

Of more interest are the complete luxations of the radial head, because in many cases they are irreducible. The head may indeed be forced back seemingly into place, but as soon as the dressings are discontinued, and full extension is allowed, it is seen that nothing has been gained, as re-luxation occurs. The explanation is that real reduction never was secured. If reduction had been secured, and the torn orbicular ligament had re-united in proper position in front of the neck of the bone, it does not seem likely that the action of the biceps could destroy Nature's efforts at repair with such amazing facility and the production of so little pain.

Anterior luxation of the head of the radius alone is considered by most writers a much rarer injury than the same lesion accompanied by fracture of the ulna. Perrin (Paris Thesis, 1909, p. 17) says that every year Kirmisson sees two or three instances of the latter injury; and he quotes with astonishment the statistics of Zieger (1901), who found only 15 out of 95 cases of anterior luxation, and only 16 out of 42 cases of outward luxation of the radial head were accompanied by fracture of the ulna. Under my own care, during the last 10 years, I have had 23 cases of isolated fracture of the shaft of the ulna. Among these there were two cases accompanied by dislocation of the head of the radius, and a third with concomitant fracture of the neck of the radius. The dislocations were successfully reduced without arthrotomy, and had not shown any tendency to recur up to the time of consolidation of the ulnar fractures. The patients cannot be found now. During the same time there has been only one isolated dislocation of the head of the radius; this also was successfully reduced and had not recurred one month later, when the patient was last seen.

That the combined injury is by no means rare, is proved by the large number of isolated case reports (119) collected by Stetten in 1908 (ANNALS OF SURGERY, 1908, xlviii, 275).

To these may be added 20 previously unpublished cases included in Perrin's Thesis. Indeed the association of these injuries is so classical, that since the time of Malgaigne (1854) there has been a rule that in every case of fracture of the ulna alone, the existence of an anterior luxation of the radius should be suspected; and it may be added that in every case of anterior luxation of the radial head the surgeon should make very sure that no concomitant fracture of the ulna is overlooked.

As a matter of fact, while the fracture of the ulna usually is recognized, the luxation of the radius often is overlooked; and when swelling of the soft parts has subsided and the luxation is first noted, the surgeon should blame himself for neglecting the additional lesion. Modern text-books do not lay enough stress on this injury. It is true that the surgeon may argue that even had he recognized the luxation at first it might have been impossible to keep it reduced; and in this way he may console himself that no harm has been done. But in many cases harm will have been done, for the fracture of the ulna may unite with such deformity as to interfere very materially with subsequent treatment, or only fibrous union may result.

The association of nerve lesions, especially paralysis of the musculo-spiral nerve, has been studied with care by Stetten. He collected 9 such cases, and these, with 6 others mentioned by Perrin, make a total of 15 examples of nerve injury among a total of about 140 instances of the combined injury (luxation of the radial head and fracture of the ulna). Two of these cases of musculo-spiral paralysis appear to have developed immediately after the injury (Helferich, Albertin); in some of the others the time of onset is not mentioned, but in most it developed late, being due to secondary neuritis from pressure on the nerve or from its being stretched over the displaced radial head.

It is therefore very evident that reduction of the luxation in recent cases is extremely important. If reduction is obtained, the ulnar fracture as a rule will heal in good position without further trouble. If, however, reduction of the dislo-

cation is not obtained, the ulnar fragments will overlap or angulate, and union with deformity or non-union will result.

Recent Cases with Irreducible Luxation.—If reduction in a recent case cannot be secured by manipulation alone, the surgeon should resort to arthrotomy; but he should be sure that reduction is impossible without. Perrin says Destot attempted reduction seven times, with the aid of chloroform, and only at the seventh attempt was successful. But Stetten warns, and I think rightly, of the danger of injury to the musculo-spiral nerve by too strong pressure on the radial head, and by hyper-extension of the elbow. Perrin, moreover, would confine operative reduction in recent cases to patients over 15 years of age; but as of 86 patients whose age is mentioned 52 were under 15 years of age, this rule would exclude a large proportion of cases. The only reason for not operating on young patients is the expectation that the luxation will prove irreducible even after arthrotomy, and that excision of the head will be required, which of course would be undesirable before full growth was attained; but there seems no good reason why reduction should prove impossible in a recent case, if the operation is properly performed. In adults, I agree with Perrin that excision should be done for irreducible luxation, since here as elsewhere such a lesion is very apt to lead to dystrophic arthritis, which is painful and disabling.

The object of the operation is to remove the torn capsule from its obstructing position in front of the capitellum of the humerus, and from over the lesser sigmoid cavity of the ulna, and to suture it around the neck of radius. It is said that usually the capsule is torn transversely above the head of the radius, while the orbicular ligament is split longitudinally; thus the tear in the capsule is T-shaped, and the inner triangular flap is blamed as the obstructing factor. Unless operation is done this flap is just pushed ahead of the radius, and no matter how long the head of the radius is held in proper position it will not stay there of itself.

Perrin collected five operations for recent injury, and I have been unable to find any published since the appearance

of his Thesis, up to January 1, 1912. These cases are the following:

1. Le Dentu (1892): Case complicated by rupture of brachial artery; resection of radial head for irreducibility. Good motion recovered. Adult.

2. Delorme (1902): First operation, suture of ulnar fracture, and suture of head of radius to ulna. Dislocation recurred. Second operation, excision of radial head. Adult.

3. Durand (1909): Dislocation of radius reduced without operation; but fracture of ulna plated later. Adult. Perfect result.

4. Herman (1908): Case complicated also by fracture of neck of radius. Reduction of luxation by arthrotomy not permanent until the fracture of neck of radius was sutured. Then the luxation stayed reduced, and the ulnar fracture came into good position. Age 8 years.

5. Kirmisson (1902): Luxation irreducible by arthrotomy until ulna was sutured; this procured reduction of radius. Age 10 years. Examination 4 years later showed luxation had recurred; there was cubitus valgus of 166 degrees; flexion was incomplete, but the other movements were normal.

The results of these operations are not very encouraging, perhaps, but in the earlier operations there does not seem to have been very great effort made to suture the orbicular ligament around the neck of the radius, so as to prevent recurrence of the luxation.

In cases not complicated by ulnar fracture, operation in recent cases of anterior luxation of the head of the radius appears to have been undertaken only four times; by Sprengel, Reerink, Schede, and Bardenheuer; and in every case arthrotomy without resection was successful, as it was in the case of an old dislocation without fracture reported by G. G. Davis (*Amer. Jour. of Orthop. Surg.*, 1911, viii, 585).

Old Cases, with Unreduced Luxation.—Perrin recommends a delay of four or five months in adults, and longer in children, to see whether sufficient function will be secured without operation. Even in the best cases flexion and supination are limited; and in most cases the patients not only are unable to do any heavy work, but cannot even feed or shave themselves, or brush their own hair with the injured arm.

Perrin collected 25 operations for old unreduced luxation

of the head of the radius complicated by fracture of the ulna.[1] To these may be added the operation by Kammerer, recorded by Stetten, and that by myself, which is the occasion of this paper.

These cases are as follows:

1. G. W. Norris (1843): Adult, non-union of ulna. Resection of ulna to secure end to end apposition. Infection. Only fibrous union.

2. Swinburne (1859): Age 8 years. Eight weeks after injury did osteoclasis for deformity of ulna; then reduced luxation, set fracture, and got excellent result.

3. Dorfler (1885): Osteoclasis, but luxation could not be completely reduced by manipulation. No age or end result.

4. Kirmisson (1889): Non-union of ulna, cured by insertion of ivory peg. Good union secured, but movements of elbow not improved (luxation not reduced). Adult.

5. Gerard-Marchant (1890): Non-union of ulna. Suture of ulna; later resection of head of radius. Only fibrous union secured, but condition improved by operation.

6. Chevassu (1897): Ulna in good position. Head of radius excised. No attempt mentioned at reduction and capsulorrhaphy. Good result.

7. Albertin (1898): Paralysis of musculo-spiral nerve, treated by excision of head of radius. Good result.

8. Annequin (1898): Ulna in good position; head of radius excised. No attempt mentioned at reduction and capsulorrhaphy. Good result.

9. Gerard-Marchant (1898): Ulna in good position; head of radius excised. No mention of attempt at reduction and capsulorrhaphy. Good result.

10. Lejars (1898): For non-union of ulna. Ulna sutured by silver wire. Only fibrous union, but improvement.

11. Report by Perrin, operation by unknown surgeon in 1899. For non-union of ulna. Suture of ulna, and resection of head of radius. When seen by Perrin some years later, pseudarthrosis persisted, and state of patient was deplorable.

12. Tillmann (1901): Ulna in good position. Arthrotomy and suture of capsule. Luxation recurred.

13. Tillmann (1901): Same case as No. 12. Later excision of head of radius. Good result.

14. Schwartz (1902): Ulna in good position. Excision of head of radius. No mention of attempt at capsulorrhaphy. Good recovery.

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[1] F. J. Cotton (Dislocations and Joint Fractures, Phila., 1910, pp. 236 and 295) mentions a case of old anterior dislocation of head of radius with ununited fracture of shaft of ulna. He reduced the luxation by arthrotomy and held the radius in place by a new ligament made of fascia and wired the ulnar fracture. Though bony union was not secured the dislocation remained reduced, and a useful arm was obtained.

15. Katzenstein (1903): Ulna in good position. Arthrotomy, reduction, and capsulorrhaphy. Age 8 years. Perfect functional result, but head of radius remained subluxated.

16. Loison (1903): Malunion of ulna. Osteotomy of ulna, and reduction of luxation by arthrotomy; no suture of capsule mentioned. Luxation recurred.

17. Loison (1903): Same case as No. 16. Later excision of head of radius. No operation on ulna this time, although union in bad position had again occurred. Poor result. Motion only from 90 to 120 degrees, rotation only half normal, and marked atrophy of limb.

18. Riese (1903): Ulna in good position. Arthrotomy and reduction; suture of capsule proved impossible. The end result gave great improvement, but head of radius still subluxated. Adult.

19. Bérard (1904): Non-union of ulna. Resection of head of radius, and modelling resection of lower fragment of ulna. No mention of attempt at reduction and capsulorrhaphy. Excellent result. Adult.

20. Zschock (1904): Non-union of ulna, and radial paralysis. Suture of ulna, and later excision of head of radius for persistence of radial paralysis. Adult. Good union in ulna, better elbow motion, no improvement in radial paralysis. No mention of attempt at reduction and capsulorrhaphy.

21. Legueu (1905): Excision of elbow for ankylosis following badly united fracture of olecranon with anterior dislocation of radius. Good result.

22. Capron (1906): Ulna in good position. Head of radius excised. No mention of attempt at reduction and capsulorrhaphy.

23. Tricot (1906): Ulna in good position. Reduction by arthrotomy. Capsule not sutured. Luxation recurred.

24. Tricot (1906): Same case as No. 23. Excision of head of radius for recurrence of dislocation. Good result.

25. Lambotte (1908): Malunion of ulna. Osteotomy of ulna, and excision of head of radius, as reduction proved impossible. Perfect result.

26. Kammerer (1908): Ulna in good position, musculo-spiral paralysis. Head of radius excised. Age 19 years. No attempt at reduction and capsulorrhaphy mentioned. Perfect recovery of power in three years, but luxation persisted.

27. Ashhurst (1911): See below.

These operations may be thus classified:

A. Fourteen cases in which the ulna had united in fairly good position:

Five treated by attempts at reduction of dislocation of radius. (In two of these the capsule was not sutured.) Luxation recurred in two cases (Tillmann, capsulorrhaphy done; Tricot, capsulorrhaphy not done). Good result in three cases

(Katzenstein, Riese, Ashhurst; capsule sutured except in Riese's case).

Nine treated by excision of head of radius. In two cases (Tillmann, Tricot) for recurrence of luxation after reduction by arthrotomy; in two cases there was also musculo-spiral paralysis (Albertin, Kammerer). Good result in all.

B. Six cases in which ulna had united in bad position:

Two treated by osteoclasis of ulna and reduction of radius without arthrotomy (Swinburne, excellent result; Dorfler, result unknown).

One treated by osteotomy of ulna and reduction of radius by arthrotomy (Loison, luxation recurred).

One treated by osteotomy and excision of head (Lambotte, excellent result).

One treated by excision of elbow joint, for ankylosis (Legueu, good result).

One treated by excision of radius, for recurrence of luxation (Loison, poor result).

C. Seven cases in which ulna was ununited:

Three treated by operation on ulna, nothing done to radius (Norris, Kirmisson, Lejars, all improved).

Four treated by operation on ulna and excision of head of radius (Gerard-Marchant, with improvement; unknown surgeon, with bad result; Bérard, with excellent result; and Zschock, with improvement, but no relief of accompanying musculo-spiral paralysis).

CASE REPORT.—Thomas O'B., age eleven years, in July, 1911, fell on the ulnar surface of his left forearm, causing a fracture of the ulna, at the junction of its middle and upper thirds; and by continuance of the force the head of the radius was dislocated forward. It does not appear that the existence of a dislocation was recognized. His arm was dressed on a splint, but he did not return to have his arm redressed until three weeks later. He then came under the care of Dr. Z. M. K. Fulton, my colleague at the Episcopal Hospital, and through his interest the patient was later referred to me for operation. At this time union in the ulna was fairly firm, there was not much deformity, but the dislocation

FIG. 1.

FIG. 2.

Anterior and outward dislocation of head of radius, with fracture of shaft of ulna. Four months after injury.

FIG. 3.

Anterior and outward dislocation of head of radius, three months after reduction by arthrotomy and capsulorrhaphy. Compare with Fig. 1.

could not be reduced. Four months after injury the boy was admitted to the Episcopal Hospital, in the service of Dr. Chas. H. Frazier. Figs. 1 and 2, from skiagraphs made at this time, show the condition of the bones. The ulna had united with slight angular deformity toward the extensor surface, and the head of the radius was luxated far forward. Flexion was stopped at 50 degrees by the radius butting against the shaft of the humerus; this caused considerable pain. Extension was complete. The carrying angle was 160 degrees, that of the normal elbow being 170 degrees. Rotation of the forearm, as measured by the writer's instrument (*Amer. Jour. Med. Sc.*, 1912, i, 848), was possible through a range of 150 degrees (from 20 to 170 degrees); that is to say, there was a loss of at least 20 degrees of supination, and an increase in the range of pronation. The head of the radius was displaced upward and outward from its normal place, and was rather freely movable. There were no nerve lesions. Even momentary reduction was impossible; evidently the normal site of the radial head was filled up with soft tissues. There was a decided hollow in this location.

Operation (Nov. 22, 1911).—No Esmarch band was used. An external incision was made, three inches and a half in length, along the supracondylar ridge and downward between the brachio-radialis and the extensor carpi radialis longior. This interspace was opened and the head of the radius identified. The supinator brevis was partially detached from the neck of the radius, and pushed downward. The musculo-spiral nerve was displaced forward. The tendon of the forearm extensors was next dissected partially off the external lateral ligament of the elbow. The remains of the orbicular ligament were then plainly seen crushed against the capitellum of the humerus. At no time could there have been any possibility of reduction of the luxation without arthrotomy. The opening in the capsule was not large enough to readmit the head of the radius. The cup-shaped depression in the head of the radius was filled with granulation tissue, showing there had been some change in the cartilage. This granulation tissue was removed by sharp gouge forceps. The orbicular ligament was then raised from in front of the capitellum, it was incised in the long axis of the arm, and the head of the radius was replaced in its normal relation to the external condyle. The orbicular ligament was then carefully sutured with mattress

sutures of chromic gut to the periosteum covering the neck of the radius, to the supinator brevis, and to the ulnar attachments of the external lateral ligament. From six to eight such sutures were inserted, and there was then no tendency for the radial head to reluxate. The supinator brevis was then sutured over the head of the radius; the extensor tendon was again attached to the external lateral ligament and the external condylar ridge; and the brachio-radialis was sutured to the extensor carpi radialis longior. The skin wound was closed with chromic catgut without drainage. Not one ligature was required throughout the operation, which consumed an hour. The elbow was dressed in hyperflexion.

Some infection of the skin sutures occurred, but the deeper structures healed perfectly. The elbow was kept in hyperflexion for about five weeks, to give the orbicular ligament plenty of time to cicatrize. Rotation of the forearm was practised at each dressing, and never was painful.

The further progress of the case was slow, as regards the return of extension. Fig. 3 shows the elbow region three months after operation. Full extension was not regained for six months after operation, being aided by gentle massage and passive motion, which were instituted first three months after operation.

At present, over six months since operation,[2] the head of the radius retains its normal site in all positions of the elbow; and it cannot be forced into subluxation even by direct pressure. Flexion is present to 40 or 45 degrees, there is complete extension, the carrying angle has been restored to normal, and the arm feels much stronger than before the dislocation was reduced. There is no palpable evidence of the ulnar fracture. The result may be considered nearly perfect.

From this study, I think certain rational conclusions may be drawn:

In *recent cases* secure reduction of the dislocated radial head, by arthrotomy and capsulorrhaphy if necessary. As Kirmisson says, in such injuries, the dislocation is everything, the fracture is nothing. When reduction is secured the fracture

[2] Now, when reading proof, over nine months since operation, function is perfect.

almost invariably will fall into good position. If it does not, it may be fixed by suture or plate.

In *old cases with the ulna united* attempt reduction of the dislocation by arthrotomy and retain the radius in place by capsulorrhaphy. If reduction after arthrotomy proves impossible, as it may if the ulna has united in bad position, it is better to excise the head of the radius than to interfere with the ulna, unless the deformity in the ulna is very extreme. In such cases osteotomy of the ulna may be done.

In *old cases with non-union of the ulna* expose the ulnar fracture first, and after freeing the fragments, secure reduction of the dislocation (by arthrotomy if necessary, including capsulorrhaphy); then treat the ulnar fracture as if no dislocation had existed.

In *cases with musculo-spiral paralysis* excision of the radial head failed to secure a good result in one case (Zschock), and there is no evidence that reduction and capsulorrhaphy would not have been successful in two others (Albertin, Kammerer) in which excision was done.

ON THE FREEING OF FRAGMENTS PRELIMINARY TO THE OPERATIVE REDUCTION OF FRACTURE OF THE FEMUR.

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In descriptions of the open treatment of fractures, especially fractures of the femur, very little is said of that part of the operation which consumes the most time, namely, the freeing of the fractured ends. In an operation upon a fracture of the femur, one usually sees a rapid exposure of the bone surfaces nearest the operator, after this, the speed of the operation diminishes, as the difficult and laborious freeing of the posterior surfaces goes on. From time to time, attempts at reduction are made, followed by further freeing of the soft parts. Finally, with a good deal of effort, reduction is accomplished, and position is maintained by bone-holding appliances; the rest is easy routine work.

It is well known that the longer a fracture remains unreduced, the more contraction of the soft parts there is. In other words, recent fractures are much easier to reduce than those of some weeks' standing. In fractures of several months' duration, the soft parts may become so inelastic that reduction can be accomplished only by the use of such an undue force that rupture of important vascular and nervous structures is rendered likely. Under such circumstances, a certain amount of bone must be resected before there can be a reduction without dangerous tension upon the soft parts.

The two chief opponents to reduction in fairly recent fractures with non-union (after two months) are, first, connective tissue deposited in the vicinity of the fracture—this includes not only callus, but also scar tissue of the soft parts lacerated at the time of fracture; second, the contractured

aponeurotic insertions of the muscles along the linea aspera, which can be considered as one structure.

As said before, the freeing of the fragments of their soft part attachment on the side nearer the operator (anterior and lateral) is easy; while on the side away from the operator (posterior and mesial) it is difficult, because the fragments themselves lie in front of the operative field, and the soft parts crowd in from either side. One of the chief structures hindering reduction, namely, the aponeurotic insertion of the muscles along the linea aspera, lies in this posterior region which is so difficult of access. This region can readily be made accessible by the following method:

As soon as the anterior surfaces of the bony fragments are freed, an assistant continually makes an attempt to kink the limb;[1] the soft parts hindering this are divided by re-

FIG. 1.

Diagrammatic representation of two fragments tilted anteriorly (upward); each has been freed of its muscular insertion (along the linea aspera) for an inch or so. The edge of the aponeurotic structure (*AB*) is shown joining the fragments.

peated small cuts against the bone on either fragment. As the resisting structures are gradually severed, the two fragments form an angle which constantly becomes more and more acute. It is now possible to see the posterior aspect of both fragments, and to free the bone of its aponeurotic attachments along the linea aspera for an inch or more on either fragment. By cutting against the bone, injury to vessels and nerves can be avoided. The limb is now straightened out and reduction is attempted; if sufficient relaxation has not been gained, the fragments are again brought vertical

[1] The angle thus formed has its apex pointing anteriorly.

and parallel and their ends pulled apart (Fig. 1), so that the freed aponeurotic attachment along the linea aspera joining them is exposed, put on tension, and divided. In doing this tenotomy, great care must be observed, in order to avoid injury either to the femoral vessels and long saphenous nerve in Hunter's canal (in fracture of middle third of the thigh), or to the sciatic nerve, for at certain points these structures lie just beyond the aponeurotic tissue which is being divided.

To recapitulate: The aponeurotic insertions of the muscles along the linea aspera can be considered as one structure. It constitutes one of the chief obstacles to the reduction of a femoral fracture. A blind division of this structure (tenotomy), as it lies covered by the ends of the fractured bone, is a foolhardy procedure, because of possible damage to the sciatic nerve or to the femoral vessels, and because of the difficulty of controlling hemorrhage in such a situation. By gradually kinking the limb at the point of fracture, and dividing the soft parts which hinder this attempt, the posterior aspect of both fragments becomes readily accessible. Usually the freeing of both fragments of their soft part attachments (including tendons) for an inch or so suffices; but if not, the linea aspera "tendons" can be exposed as before and a careful tenotomy be done.

The procedure is a simple, rapid, and safe method for freeing the ends of fragments. It removes a large proportion of the resistance to reduction offered by the soft parts. This method of exposure and division of tendinous structures opposing reduction is available in fractures of the other long bones which come to open treatment.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting held May 6, 1912.

DR. GWILYM G. DAVIS, President, in the Chair.

ANTERIOR DISLOCATION OF THE HEAD OF THE RADIUS.

DR. ASTLEY P. C. ASHHURST read a paper with the above title, for which see page 631.

ARTHROTOMY OF THE KNEE.

DR. ASTLEY P. C. ASHHURST reported the following cases:

1. *For "hydrops articuli." Perfect function eight years later.* James L. was a grave-digger, aged 30 years. He had never been ill, but one day in the summer of 1903 he had a sudden pain in his right knee, which continued all one day, and then left him never to return. In June, 1904, this knee began to feel clumsy and weak; he had not injured it, and it did not hurt him. After three months of increasing disability he came to the Orthopædic Hospital, service of Dr. G. G. Davis. Examination showed the knee irregularly swelled up by what was thought to be an intra-articular growth, of semifluid consistency; the patella was raised, and there was a marked prominence on each side of the tendon of the quadriceps extensor. The swelling felt "myxomatous" rather than fluid. On September 1 an aspirating needle was introduced, but no fluid could be withdrawn. On September 5, 1904, the man was etherized, and Dr. Ashhurst made an incision on each side of the patella; the joint contents were turbid serum; no flakes of lymph nor rice bodies were present. The under surface of the patella was eroded, as was the apposed surface of the femur; there was no roughening of the capsule. The joint was wiped out with iodoform gauze, and a large double drainage tube was passed

from one side of the joint to the other. A sterile dressing and a posterior splint were applied.

The tubes were removed within a few days, as soon as all discharge ceased. On September 28 the incisions were healed, and the limb was put up in plaster of Paris. There had been no pain since operation. On October 13 the patient was discharged, still wearing the gypsum case. This was removed in November, and an elastic bandage was worn for about a year. Some disability persisted for nearly a year.

In the summer of 1906, two years after operation, examination showed perfect function. He still wore an elastic knee-cap, and there was slight atrophy of the thigh.

At present, nearly eight years after operation, the patient is in perfect condition. Flexion and extension in the knee are normal; the patella is freely movable; there is no effusion; and the joint is symptomless. He is still digging graves, and never has had any pain or discomfort in the knee since the operation.

2. *For recently dislocated semilunar cartilage.* Florence S., 24 years of age, wore high heeled shoes, and tripped and fell on the street. Her right knee was violently flexed, causing great pain; but with her hands she managed to straighten the leg out, and then found she could not bend it up again. She felt a tender lump on the outside of the knee, just below the femoral condyle. She was brought to the Episcopal Hospital the same day, August 29, 1911, and was admitted to the service of Dr. Chas. H. Frazier. Examination confirmed the above sad state of affairs. There was a tender lump below the external condyle, the knee was locked in extension, and could not be flexed. X-rays showed nothing. The next day Dr. Ashhurst operated. While the patient was being etherized, the lump, which up to that time had been immovable, suddenly disappeared, and motion in the joint became free. On opening the joint over the external semilunar cartilage, there was a gush of turbid synovial fluid. The external semilunar moved freely on the head of the tibia, but retained its attachments to the capsule, as well as anteriorly and posteriorly. No other lesions were observed. The loose cartilage was excised by the aid of a sharp hook and scissors, and the joint was closed without irrigation or drainage, and plaster-of-Paris dressing applied.

On the fourth day the temperature rose to 102° F., and there was a great deal of pain in the joint; but the pulse was only 85.

Three weeks after operation the gypsum case was removed, and the wound was found healed. Subsequently there was a little skin infection, but culture of the pus showed no growth, and smears showed no bacteria. One month after operation the knee could be flexed to 150 degrees. In November the patient, who had resumed her high heeled shoes, fell again in the street, and suddenly flexed the injured knee to more than a right angle; this caused slight effusion, and she was laid up for a few days. But on subsidence of this, no disability remained, and she has now recovered perfect function, and spends much of her time in dance-halls, as before her accident.

3. *For recurrent dislocation of semilunar cartilage.* John W. hurt his left knee playing football, when 23 years of age. It always troubled him since. In March, 1911, when 30 years old, and twice between that date and September, 1911, he suffered from acute dislocation of the internal semilunar cartilage of this knee. Suddenly, following twist or sprain, a lump appears below the internal condyle, the knee locks in flexion, and when straightened out by force cannot be bent. Acute synovitis follows, and he is laid up for a few days. He was admitted to Dr. Frazier's service in the Episcopal Hospital three weeks after the last attack. On September 9, 1911, Dr. Ashhurst removed a frayed-out internal semilunar cartilage, which was entirely unattached except to the capsule and at its posterior end to the tibia. The whole cartilage was removed. The gypsum case was discarded three weeks after operation, and in two months the knee had become entirely normal and has remained so since, now eight months.

OPERATIONS FOR OLD FRACTURES OF THE ELBOW.

Dr. A. P. C. Ashhurst also presented the records of the following cases:

1. *Arthroplastic operation for old fracture of external condyle of humerus, with gunstock deformity.* James W., aged five years, broke his right elbow in July, 1908. When he came under Dr. Ashhurst's care in October, 1908, flexion was possible only to 50 degrees and extension only to 145 degrees. There was cubitus varus, the forearm making an angle of about 200 degrees with the arm. Skiagraph showed fracture with outward rotation of the external condyle. For six weeks subsequently light massage and passive motion were employed, with the result that motion was

increased 10 degrees in flexion, the range now being from 40 to 145 degrees.

On November 18, 1908, Dr. Ashhurst operated, in the Episcopal Hospital, service of Dr. C. H. Frazier. The joint was opened by an external longitudinal incision. A little granulation tissue, springing from the humerus and inside the joint cavity, was excised. The external condyle was found to be displaced down and back, as well as rotated. Enough of this was removed to permit full extension of the elbow, as well as to overcome the cubitus varus. The olecranon fossa on the posterior surface of the humerus was also deepened by curette, so as to admit the olecranon in full extension. A cross incision was then made in the skin, backward across the arm from the upper extremity of the longitudinal incision, and a flap of fat was dissected up, with its base below; this fatty flap was then inverted over the surface of the external condyle, all the cartilage of which had been removed down to the bony centre for the capitellum. The fatty flap was sutured in place with chromic gut, and this was used for repairing the external lateral ligament and for closing the skin. The elbow was dressed in hyperflexion. The time of the operation was 50 minutes.

The first dressing was made ten days later, when the wound was found healed, and all the skin sutures absorbed. Motion was free and painless from 45 to 90 degrees. The arm was now carried in a sling. On December 5, there was motion from 40 to 140 degrees.

At present, three and half years after operation, there is perfect function, no varus deformity, full flexion, but extension only to 150 degrees.

2. *Arthrotomy and suture of fragment for ununited fracture of external condyle of humerus.* Mary G. fractured her right elbow when two years old. At the age of nine years she applied to Dr. Ashhurst for deformity and slight disability from weakness of the joint. Examination showed an ununited fracture of the external condyle, which moved with the head of the radius in flexion and extension movements, which were not limited. The condyle was freely movable on the shaft of the humerus anteroposteriorly. In full extension there was cubitus valgus of 160 degrees; and this could be increased to 140 degrees by abduction of the forearm, which caused ascent of the external condyle on the

shaft of the humerus. A skiagraph showed an ununited fracture of the external condyle, with rotation of the fragment anteriorly and outward, around a longitudinal axis.

The girl was admitted to the Episcopal Hospital, in the service of Dr. C. H. Frazier, and Dr. Ashhurst operated on October 23, 1909.

An incision four inches long was made on the outer side of the joint, between the supinator longus (brachioradialis) and the extensor muscles; the radial nerve was displaced anteriorly with the brachioradialis, and the humerus was bared. The elbow-joint was then opened through the line of fracture, and fibrous union was found. The humeral side of the fracture was chiselled off until healthy bone was found, and an attempt was made to rotate the condyle inward and backward, to restore normal relations. To accomplish this most of its attachments had to be severed, but the external lateral ligament passing from it to the orbicular ligament of the radius was carefully preserved. It was impossible to secure very accurate apposition. Then the fractured surface of the condyle was chiselled off. Best apposition was obtained with the elbow in full extension. The condyle was then sutured to the shaft with three chromic gut sutures, one of which passed through bone on both sides (shaft of humerus and centre for capitellum), and the others through cartilage and periosteum. The deep fascia was closed with chromic gut sutures and the skin with silkworm gut. A few strands of plain catgut were inserted as a drain. The arm was dressed in full extension, with the forearm in full supination, on a straight anterior splint, the carrying angle being about 170 degrees. The time of the operation was 70 minutes.

The first dressing was made ten days later (November 2, 1909). The catgut drain had been absorbed, the skin incision was healed, and the silkworm gut skin sutures were removed. Rotation in the forearm was normal in extent and painless; flexion to about 160 degrees was made without pain. The arm was again dressed in full extension. A week later the elbow was dressed at an angle of 135 degrees, flexion beyond which was painful. The fragment seemed firm, but in full extension there was still a little lateral mobility. Progress thereafter was uneventful.

At present, two and a half years after operation, there is perfect function, flexion and extension being complete as before operation. There is no more lateral mobility in the joint than in the

normal left elbow, the external condyle is firmly united to the humerus, and the only deformity is slight increase in cubitus valgus, which is 150 degrees, the normal carrying angle in this girl being 170 degrees. This may be remedied by an osteotomy of the humerus above the condyles.

3. *Old supracondylar fracture of humerus, with inward displacement of lower fragment, giving gunstock deformity.* James L., a boy of seven years, on July 26, 1911, fell over backward, crushing his left elbow between his back and the ground, his arm being held across his back at the time. The physician who was consulted dressed the elbow in a flexed position, probably corresponding to the "Velpeau" position. That night the father removed all the bandages because the arm was painful. The next day another physician dressed the elbow. Three weeks later the child was first seen by Dr. Ashhurst. The elbow at that time was dressed at an angle of 80 degrees, and was held against the chest by adhesive plaster. Motion was limited and painful. There was a sharp projection of bone in the region of the external condyle, and the skin overlying this was on the point of sloughing. On account of the swelling the exact relation of the bones could not be determined. The elbow was kept quiet until all inflammatory symptoms had subsided.

Skiagraphs made Sept. 19, 1911 (Figs. 1 and 2), showed a supra-condylar fracture, with marked internal displacement of the lower fragment; the sharp bony projection was caused by the lower end of the upper fragment jutting into the soft parts above the external condyle. A photograph made from behind, with the elbow flexed to a right angle and the bony points marked in ink, shows the deformity very well (Fig. 4). By October 27, three months after injury, the range of motion was still limited to 35 degrees of flexion and 140 degrees of extension. The carrying angle was lost, there being cubitus varus of 200 degrees (*i.e.*, the forearm was 20 degrees to the inner side of the axis of the arm, instead of about 10 degrees to the outside). There being nc prospect of further improvement without operation, the patient was admitted to the Episcopal Hospital, in Dr. C. H. Frazier's service, and was operated on by Dr. Ashhurst before the members of the Congress of Surgeons of North America, November 10, 1911.

Operation: An incision four inches long was made on the

FIG. 1

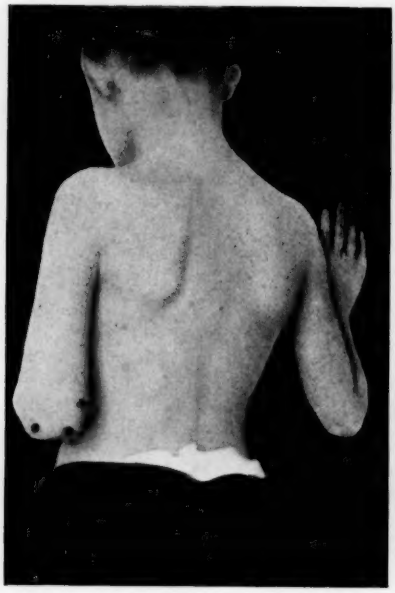
FIG. 2.

FIG. 3.

Old supracondylar fracture of humerus, inward displacement of lower fragment producing cubitus varus. (Case III.) (Figs. 1 and 2, before operation.)

Four months after operation.

FIG. 4.



Old supracondylar fracture of left humerus, inward displacement of lower fragment. (Case III.)

FIG. 5.

Same patient six months after operation. Dots on condyles and olecranon. (Case III.)

posterior surface of the elbow, splitting the triceps muscle down to the shaft of the humerus. The periosteum was stripped away from the shaft on both sides of the incision, and *all around the shaft,* carrying the ulnar nerve well out of harm's way. A smooth retractor was then passed around the humerus, to protect the soft parts on the anterior aspect of the joint. The triangle of new formed subperiosteal bone, above the internal condyle, was then excised. Then the humerus was cut across in the line of the old fracture, just above the condyles, the section being made by osteotome and mallet. The lower fragment was then pushed forward. The elbow-joint had not been opened. Then, with Hey's saw, one-eighth of an inch of the lower end of the diaphysis was sawed off, and by means of gouge forceps and Liston's bone forceps the lower end of the diaphysis was trimmed until it fitted the elbow fragment of the humerus. This lower fragment was very small, extending only from the level of the olecranon fossa down into the joint, and nothing could have been removed from it without entering the joint, which it was not desired to do. The transverse axis of the upper fragment was made such that when fitted to the joint fragment the carrying angle was restored. It was then ascertained that both in hyperflexion and in extension to 170 degrees the lower fragment held its normal relation to the upper fragment without bone suture. The wound was then closed by interrupted chromic catgut sutures in layers, as follows: (1) periosteum; (2) deep fascia over triceps; (3) skin. No drain. After the wound was sutured, the fracture was reduced (by hyper-extension, direct traction, and subsequent hyperflexion) just as if it was a recent injury, with no wound present. The elbow was dressed in hyperflexion (20 degrees), the forearm being brought up upon the arm directly in the sagittal plane. The wound was then dressed, and the elbow maintained in hyperflexion by the usual bandage. The time of the operation was 35 minutes.

A skiagraph (lateral view) made four days later showed that the lower fragment was tilted a little forward, so the hyperflexion was slightly reduced at the first dressing, November 15.

There was some infection of the skin sutures, but otherwise healing was uneventful and entirely painless. After three weeks the arm was carried in a sling, and soon after this active use was encouraged.

As extension was slow in returning, a light brace with a

Stromeyer screw was applied, at the suggestion of Dr. G. G. Davis, some three months after operation. This was worn at night, and in a few weeks full extension could be secured every evening, very soon after the brace was put on, but during the day when it was not worn voluntary extension was somewhat limited.

At present, six months after operation, there is easy voluntary extension to 160 degrees, flexion to 35 degrees, a normal carrying angle, and scarcely any visible deformity (Figs. 3 and 5).

Dr. William L. Rodman said that in his experience when he had opened and drained these cases, especially the very septic cases where the joint was filled with pus, recovery occurred without ankylosis. When he had tried the more modern plan of aspirating these joints and throwing in formalin he had not gotten good results. He had at present a case on hand where the latter method has been pursued for streptococcic infection and there will be, he was sure, almost complete ankylosis. He could recall a number of cases where the opposite plan has been used with the most perfect successes. He recalled the case of a man under his care three months ago with a joint full of pus, where he aspirated the joint and put in formalin; the man got so much worse in 48 hours that he opened it, and put a tube in the joint, and the day the patient left the hospital he had about half as good motion as usual, but to-day his motion seems practically normal. He remembered a painter on a house who fell and a headless nail went into the knee-joint, and when he saw him the joint was full of pus, and there was an erysipelatous inflammation up to the thigh. He opened the joint, found a large amount of pus and also the headless nail. Two tubes were introduced for four weeks. About five years ago he met this man walking on the street and he had as good motion as any one could want. The erysipelatous inflammation was so extensive that all the superficial fascia sloughed out between the knee and hip.

He remembered also the case of a boy with pyæmia caused by osteomyelitis of the right tibia. The bone was entirely destroyed from one end to the other, the superficial tissues infiltrated extensively, and the joint full of pus, requiring an amputation at the lower third of the thigh. The opposite joint was also full of pus and yet there was no destruction of bone below, so feeling it would be most deplorable if the one leg he had were stiff, he put in a tube, irrigated daily with bichloride solution for weeks, and there was no ankylosis.

Another man with marked tuberculosis had a condition of most extensive involvement of the inner condyle of the femur, which was removed. He wore a drainage tube for six weeks, the joint being irrigated from day to day. He then weighed 85 pounds; to-day he weighs 150 pounds and there is no difference in the motion of his two joints. In Dr. Rodman's opinion open arthrotomy and drainage in purulent conditions particularly is the treatment of choice in spite of the positive statements from many surgeons that it is practically invariably followed by ankylosis. There has not been marked pain accompanying the injection in his hands of a 2 per cent. glycerin solution of formalin. He had also used it in empyema cases and had never seen any case relieved by it.

THE TREATMENT OF UNUNITED INTRACAPSULAR FRACTURES OF THE FEMUR.

DR. GWILYM G. DAVIS read a paper with the above title, for which see page 622.

DR. JOHN B. ROBERTS asked Dr. Davis to tell how to treat fracture of the neck of the femur in comparatively aged women, in whom the line of fracture runs through the base of the neck and far enough down the shaft to allow the lesser trochanter to be part of the upper fragment. That is the fracture which to him is the most difficult to manage and it needs orthopædic work which he had not been able to give it. In the ordinary fracture through the base of the neck he expected fair union through longitudinal traction with some form of Buck's extension, but the fracture higher up is the one apt to be followed by non-union. When the fracture runs downward leaving the lesser trochanter attached to the cervical fragment, there is an opportunity for the iliopsoas muscle to tilt the upper fragment upward and outward. Such deformity should be nailed or treated with Hodgen's or Smith's splint, or by vertical traction, such as is used in fractures of the femur in infants. By the last method it is more easily possible to get the bed-pan under the buttocks.

DR. JOHN H. JOPSON took exception to one point in the paper, that is to say the inefficiency of longitudinal extension in fracture of the neck of the femur either in middle-aged or old people. He was not as gloomy about the prognosis of these cases as a good many surgeons are. It is mainly a question as to whether they will stand confinement to bed; in the majority of cases, if the

treatment is persisted in a good result will follow. He had seen recovery with good function in one patient aged 95.

Dr. Joseph M. Spellissy said that he was surprised at the frequency with which Dr. Davis met with non-union of fractures in middle-aged people. Dr. Spellissy agreed with Dr. Jopson that, usually, with persistence of longitudinal extension even in the very aged, union can be obtained, and stated that he had obtained union in a patient aged 86 years.

He emphasized the need of lateral counter-traction when lateral traction is employed in fractures of the femur.

Dr. A. P. C. Ashhurst said that some years ago with the help of his resident at the Episcopal Hospital he traced the fractures of the femur which had been treated there for the previous three years and he found that the results in fractures of the neck of the femur were not as bad as he expected; 13 out of 21 patients traced had no other disability than a limp; and he thought Dr. Davis's unfortunate experience was due to the fact that the Orthopædic Hospital is a clearing house from all over the city and surrounding districts for all the bad bone results from all surgeons. They come there helpless, and Dr. Davis turns them out with good results.

It is a matter also of literary interest to recall that it was a surgeon named Phillips in 1869 who introduced the method of longitudinal and lateral traction which is now known by the names of Ruth and Maxwell. In the *American Journal of the Medical Sciences* for 1869 he explains the reasons for using this method, and gives an excellent illustration of his method.

Dr. Addinell Hewson differed with the statement regarding the falling of the fragments of the capsule between the ends of the severed bones. If a careful dissection is made, it will be found that the obturator muscles, particularly the external obturator, is in such close contact with the neck and head of the bone and is of such density as to act as a band holding the neck of the femur firmly in place. Ventrally, the psoas and iliacus act as a band in the opposite direction; while portions of the capsule are extremely thin in contact with these tendons mentioned, there are other portions, as the Y-shaped ligaments, the pubo femoral and the ischio femoral, these are for the most part, away from the attachments of the muscles named. He believed that surgeons fail to take into consideration these obturator muscles because of

their forgetfulness of the anatomy of the part. If a dissection is made, it is really surprising to see the extent of the obturator muscles and the iliopsoas in relation to this joint. Dr. Davis spoke of Smith's anterior splint in the treatment of fracture of the femur. He thoroughly believed with him, in the use of this splint in preference to Buck's extension. If the former is properly applied, the extension thus obtained will reduce a certain amount, if not all, of the deformity. Certainly the patients are much more comfortable than with the Buck's extension. He failed to see how one could, with Buck's extension alone, keep the hip joint absolutely quiet when the patient is called upon to use the bed-pan, whereas in the use of Smith's anterior splint, the seat of fracture is kept perfectly at rest, and the patient can use the bed-pan and be clean, without disturbing the fragments in any way.

Dr. G. G. Davis (in closing) remarked that as regards Dr. Roberts's peculiar fracture, he had not seen many of that type. Ordinarily the cases have been first those of the neck high up, entirely intracapsular, next those down toward the base of the trochanter, third those through the trochanter, and finally those at the juncture of the upper and middle thirds of the shaft of the femur. The last partake of the troubles peculiar to the fracture that Dr. Roberts relates; that is the type in which one must resort either to having the leg vertical, as Bryant suggested, or to the Smith or Hodgen anterior swinging splint or the double inclined plane, all of which are efficient, or to operation. When it comes to the fractures through the trochanter he had never had the slightest difficulty with them. There has been no trouble in their uniting and he had never seen non-union in that type.

He regretted very much that Dr. Jopson should have so publicly stated his preference for the simple longitudinal traction for fractures of the neck of the femur, because he was perfectly well convinced that the bulk of cases of ununited fractures of the neck of the femur have been treated in that manner. Not only that, but that the treatment is very much more inefficient than is the Phillips, or the Ruth and Maxwell method of lateral and longitudinal traction or the method of extreme abduction.

As regards the number of cases, he referred in his paper to 16 cases. He had just gone on service at Blockley where there are two more, and there is another case he had been asked about in California, and no doubt before the year ends

he would come across one or two more. They are certainly prevalent in this community. Most of them have been treated with longitudinal traction. He knew very well the course these cases take without treatment, and it was to illustrate this that he added his last case, in which there was a person who had, three months after injury, absolute non-union and disability for a whole year, and yet afterwards obtained excellent results. But when a patient has been operated on, then goes to work and is the means of getting another patient to come who has not been operated on, he took it as evidence that when these patients discuss things they find the condition of the operated better than the non-operated case, otherwise they would not apply for treatment by operation.

As regards the capsule between the fragments it does not get between them as it is pushed upward.

SPRAIN FRACTURE AND DISLOCATIONS.

Dr. G. G. Ross and Dr. Lever F. Stewart (by invitation) read a paper with the above title, for which see page 599.

Dr. B. A. Thomas protested against the use of the term "sprain fracture," saying that inasmuch as there are so many cases of severe contusion in which the same pathology exists we will soon have the term "contusion fracture" and "dislocation fracture," etc. He therefore entered a plea that these fractures associated with sprains and contusions be called *molecular* fractures, this term being much more scientific.

Dr. G. G. Davis said that in the making of a good many lesions on the cadaver for teaching purposes the so-called sprain fracture was very frequent. It bears out the experience of the writers of the paper. Recently he had a case of luxation of the shoulder in a living person and it was distinctly seen in the skiagraph that the supraspinatus was ripped up with a distinct line of fracture at its point of attachment.

SURGICAL LESIONS OF THE RIGHT ILIAC FOSSA OTHER THAN APPENDICITIS.

Dr. Charles H. Frazier read a paper with the above title, for which see page 582.

Dr. John B. Roberts said that he had had occasion to operate that day on a case of intestinal obstruction which had been

operated on by another surgeon for appendicitis eight or ten months ago. An abscess had then been emptied in which it was necessary to put a drain. The patient still had the pains of which he complained long before he had the operation for appendicitis. He found a distinct Lane kink and other evidences of old adhesions, which may have been present before the appendix operation, for he declared his symptoms of pain were not relieved by the removal of the appendix. He found a constricting cord around his ileum, which caused the obstruction. Whether this was the remains of the omphalomesenteric duct or not he did not know.

SILK TENDON (LANGE) REMOVED TWO YEARS AFTER INTRODUCTION.

DR. A. BRUCE GILL said that the purposes of operative treatment of paralysis, aside from simple correction of deformity, are as follows:

1. The restoration of complete muscular power and normal function. The anastomosis of nerves is an attempt to secure this; but, while this would be the ideal procedure were it successful, it is at present a most uncertain operation.

2. The restoration of muscle balance with subnormal power. This is attempted (1) by tenotomy or tendon lengthening of the stronger muscles; (2) by tendon shortening of the weakened muscles; (3) by transplantation either of an opposing strong muscle or of a distant neutral muscle, using silk, if necessary, to lengthen the tendon; (4) by a moving of the joint itself in order to lengthen the arm of the lever on which the weakened muscles operate and to shorten correspondingly the arm on which the stronger muscles exert their power; and (5) by the implantation of silk check ligaments or by the Jones's skin plastic operation, which prevents the over-stretching of the weakened muscles and permits them to operate to greater advantage.

3. The restoration of stability of a limb without muscular power or the fixation of a flail joint in the best position for function. This may be secured (1) by arthrodesis, (2) by the implantation of silk ligaments, and (3) by the Jones's plastic method.

Professor Lange of Munich, by experiments begun in 1899, introduced and established the use of silk ligaments and tendons,

although artificial tendon had been used as early as 1875. He states that silk prepared by boiling in sterile water may remain uninfected in the human tissues indefinitely; but that it may become infected from the blood years after its implantation, as it offers a favorable culture medium for micro-organisms. If the silk be boiled in corrosive sublimate solution, it remains forever antiseptic, as the silk and the sublimate enter into a chemical union; but the irritation of the sublimate produces a collection of sterile pus about the silk. But sublimate silk coated with paraffin is both antiseptic and non-irritative. He further states that such silk implanted in human tissues causes a formation of fibrous or tendinous tissue around the silk and within its meshes, and that this tendon becomes as thick as a lead-pencil or even a little finger.

On April 26, 1910, Lange operated on a ten-year-old boy in the Widener Memorial Home for Crippled Children. The patient had quadriceps paralysis. He transplanted the semitendinosus muscle to the anterior surface of the tibia, using a heavy silk cord to lengthen the tendon. At the same time two similar cords were carried subcutaneously from the tendon or fascia below the tensor fasciæ femoris to the same point in the tibia, an inch below the tibial tubercle. Here several of the silk cords were sewed firmly to the periosteum and the ends of all tied together, with the knee in full extension. The limb was fixed in plaster for three months, at the end of which time the knee was maintained in extension when the thigh was raised from the table. A protective brace was worn subsequently. At the end of another three months it was noted that the knee was flexed to 110 degrees and that the patient had no power to extend it or hold it in extension. At the end of a year the leg could be completely flexed on the thigh and there was no voluntary power of extension. The thickened artificial tendons could be rolled loosely beneath the fingers and could be traced to just below the patella.

On March 28 of this year, Dr. E. B. Hodge, by whose courtesy this case was now reported, explored the site of the former operation. A fibrous or tendinous cord as large as a lead-pencil was found firmly attached to the tibia. Above the patella it divided to go to its two points of origin. All the silk cords were pulled loose from the tibia and lay within the fibrous sheath with their ends about two inches above the point of their original tibial

attachment. The artificial tendons were relaxed even when the knee was fully flexed.

Two new silk cords were quilted into the artificial tendons. Two holes were then drilled through the crest of the tibia just below the former point of insertion. The silk cords were passed through the holes, some through one and the rest through the other. They were sutured to the periosteum and their ends tied together. A piece of the old silk was accidentally pulled out of its sheath and the semitendinosus tendon. It apparently was not attached to its sheath at any point, as it was pulled out of it almost as easily as a string is pulled out of water. It is apparent that the silk is not at all penetrated by the fibrous tissue.

This case was considered to be worth reporting because it shows the results of one of Lange's own operations, in part substantiating his claims and in part refuting them. It also indicates that a periosteal attachment of the silk cords is not always strong enough to withstand the strain upon it.

RESULTS OF PLASTIC TO RELIEVE CICATRICIAL CONTRACTION.

Dr. J. M. Spellissy exhibited photographs illustrating results obtained from plastic flap transplantation in two cases of cicatricial burn contracture, and presented the second patient.

Case I.—L. F., aged five, admitted to the Methodist Hospital February 1, 1905, exhibited the condition in which the mucous membrane of the lower lip was pulled down below the sternal notch; and the whole front of the chest and arm down to the level of the elbow, to be a continuous cicatrix obliterating the profile outlines of the neck and drawing the angles of the mouth down to the lower borders of the clavicles.

First operation (February 24, 1905): At the suggestion and with the assistance of Dr. John B. Roberts a straight flap about two and a half inches in breadth, having its base at the neck, was dissected off the left side of the back from the ninth rib upward, swung into the space and sutured to the edges of an incision made at the base of the neck, separating the much thickened scar tissue down to the muscles, from a vertical line passing through the right ear to a similar position on the other side. The end of the flap reached but to the middle line of the neck. Marked improvement resulted from this operation, the mucous membrane

of the lower lip having permanently come up as far as the border of the chin and the profile of the neck and chest being much better.

Second operation: On April 14, 1905, a similar flap, but longer, with an L-shaped end, was dissected from the left back and side, and sutured into the gap made by again incising the cicatrix in front and at the left side of the neck. The blood supply of the L-piece was defective and the latter sloughed away, so that while still further improvement was achieved in the full face and profile appearances of the neck and chest and of the eversion of the lower lip, yet the sloughing of the end of the flap lost the closure of the lower lip as obtained on the operating table.

Third operation: As all skin for flap transplantation from the patient had been used, a third flap, on June 7, 1905, volunteered by her brother, a boy of about 14 years, was dissected from the under surface of his left arm. The base of the flap was at the internal margin of the arm, of about three and a half inches in breadth and of about the same length backward. It was dissected from the internal and posterior surfaces of the arm and reflected forward. The cicatrix of the sister's neck was again incised and freed until the lower lip easily remained closed. For a week prior to the operation patient and brother were daily trained in immobilization on two mattresses that had been sewn together, the hips and shoulders of the patient and her brother being strapped to the mattresses, his mattress having a slightly higher level than hers. The patient and the flap-donor lay on their backs with their heads in opposite directions. Their chins faced each other, so that when his left arm was placed across her upper chest, from her left side, with his elbow and forearm flexed at right angles with his arm and resting on a sand bag at the right of her head as shown in the diagram, his arm did not rest upon her chest but just touched it at the base of the neck. In this position the flap from the brother's arm was sutured into the gap in the sister's neck, promising permanent closure of her lower lip without contracture, when at a later stage the transplanted flap would be separated from the donor. Unfortunately, several minutes after the introduction of the last suture the patient suddenly suffered respiratory failure, and despite immediate cutting of the sutures, separation from her brother, the use of artificial respiration, and all restorative aids, she died. Throughout this opera-

tion the ether had been better borne than in the two preceding ones. The dense cicatrices enveloping her chest and in the second and third operations her back, because of the flap scars, completely surrounded her thorax and seriously and at last fatally embarrassed respiratory action.

CASE II.—E. G., aged eleven, admitted to St. Joseph's Hospital on August 2, 1910, and transferred on October 1, 1910, to the service of Dr. Spellissy. She exhibited sulphuric acid burns upon her face, right leg, forearm, elbow, and arm. By January 15, 1911, cicatrization of the burn involving the lower arm, elbow, and arm was complete. The resulting contracture did not permit extension beyond a right angle, as shown in Fig. 1.

First operation: On January 31, 1911, the cicatrix at the right elbow was incised across its anterior surface until the arm could be fully extended. The denuded space was some five inches in length. The extended arm was brought close to the right side of the patient and a flap equal to the length of the denuded surface dissected from her right side. Its breadth was about three inches, and it was reflected forward, the base being anterior and in line with the axillary fold. Longitudinal flaps were next dissected from above and below the area of the denuded side. They were slid together and sutured to each other and to the skin at each side, leaving no bare space. The under side of the reflected flap was then marginally sutured to the denuded space in the patient's extended arm except where the flap was continuous with the skin of the abdomen.

Second operation: On February 27, 1911, the plaster jacket which had enveloped the affected arm and chest of the patient since the first procedure, and the flap uniting the patient's arm to her abdomen, were cut and the margins of her wound freshened and sutured. A new cast was applied to the patient's arm still in extension but free from her body. The cast was removed and the patient presented to the Academy, exhibiting perfect function, as shown in Figs. 2 and 3.

DIVERTICULITIS OF THE SIGMOID.

DR. GEO. ERETY SHOEMAKER showed a specimen removed by resection from a woman aged 61 years. Within the last five years attacks began which were characterized by pain and soreness in the median and left abdomen, generally accompanied by

constipation. An attack occurred three months before and another within two weeks of the operation, both attended by Dr. Brumm. No mucus nor blood in the stools, no diarrhœa, nor vomiting, but soreness with fever. Loss of weight ten pounds in a year. A watery, bloody, and brownish discharge from the vagina had occurred daily for several weeks and gave rise to a suspicion of carcinoma of the body of the uterus, but vaginal examination showed no other indications of this. A mass, however, was felt behind to the left and close to the uterus, elongated and tender, too high to be felt by the rectum or seen by the sigmoidoscope, the latter causing too much pain for high introduction. The rectum was normal. The mass appeared to be along the intestinal wall.

Operation: Median incision. Uterus, tubes, and ovaries small and not obviously diseased though adherent on the left. Mass found to involve the sigmoid, which was contracted and made rigid from a point about three inches above the recto-uterine fold. Fat and epiploic appendages through this area were inflamed, red, and adherent. The hardness was not stony, and except at one point was not like carcinoma. Being unable to make a satisfactory end-to-end or side-to-side anastomosis of the large bowel after excision of the mass, on account of surrounding fat and inflamed tissue, the small intestine at a point six inches from the ileocæcal valve was united by lateral anastomosis to the front of the rectum, using clamps, and linen suture. Drainage slight, no leakage at any time. Tube out in 48 hours, pulse fair. Third day upper abdomen flat, some distention low, nausea. Fourth day flatus and five liquid stools. Fifth day many loose stools, epigastric distress, no distention above navel. Stomach irritable. In the night of the seventh day there were signs of acute cardiac dilatation and death occurred. There was no general peritonitis, the temperature range was low and improving, the wound was clean. There was much complaint of intestinal griping pain. As far as could be determined the colon did not distend.

The specimen shows inflamed intestinal wall with fifteen to twenty inflamed diverticula, some of which extend through the muscular wall into diverticula and some do not.

Dr. Shoemaker added that even with the abdomen open the diagnosis may be difficult, especially in those cases where pus has formed. It may be that some of the obscure, diffused, slug-

gish suppurations of the abdomen extending up along the large bowel have been really instances of diverticulitis, though supposed to have originated in the fallopian tube or elsewhere. Such a case is now recovering in the hospital after drainage only, the pus had a fecal odor and the patient was toxic, but in the absence of resection the origin remains unproven.

NEPHRECTOMY FOR PYONEPHROSIS WITH SACCULATION OF THE KIDNEY DUE TO VALVE ACTION.

DR. GEO. ERETY SHOEMAKER presented a woman, 24 years old, who complained of more or less constant pain in the right side, increasing to paroxysms, accompanied by fever, and these followed by a flow of dark urine with relief. An enlargement over the right kidney in front had been noted at intervals. Weight shows decided loss. She dates right-sided distress from a fall 13 years before when the clavicle was broken. On admission to the Presbyterian Hospital examination showed the right kidney not freely movable, the size varying. At intervals it was difficult to make out, another day a rounded, tender, elongated mass appeared about three times the size of a normal kidney. The left kidney was rather inaccessible, but the X-ray later showed it to be slightly enlarged.

The urine, drawn in a sterile flask, showed a pure and abundant growth of the *Staphylococcus albus*. Hæmoglobin 66; white blood-cells 6050; red blood-cells 3,500,000. There were no gonococci.

Cystoscopy was done by Dr. Geo. M. Laws. Bladder normal. Right ureteral opening pouted and œdematous. Indigo-carmine intramuscular injection, 20 c.c. of a 4 per cent. solution. On the right it appeared as a trace in nine minutes but did not increase. On the left there was no movement of the ureteral orifice for 18 minutes, then heavy voluminous spurts appeared and continued. The right kidney therefore appeared functionally inefficient, while the left was acting well for both.

Radiograph by Dr. Newcomet. About 45 c.c. of a 12.5 per cent. solution of collargol was previously injected into the right kidney and ureter by Dr. Laws. The radiograph shows with the greatest clearness some dilatation of the ureter except near the kidney pelvis, where it is decidedly narrowed (explainable by valve action). Dilated calyces in a kidney over seven inches long

were distinctly shown, separated by partitions of kidney structure, the cortex being a shell.

Operation: Incision parallel to and close below twelfth rib readily exposed the lower dark blue pole of the kidney, the organ being long and thin. The upper portion, elongated and sacculated, was with some difficulty reached high under the ribs. Careful dissection freed the ureter, which was tied between catgut ligatures, and the vessels were secured by fine silk. There was no bleeding and no soiling of the field. Closure with fine tube superficial drain, no shock. Aseptic recovery. Urinary output from the other kidney was ample from the first. Relief from right-sided distress was immediate and permanent.

The specimen shows the sacculation due to long-continued back pressure. Shrinkage has occurred, but the X-ray plate shows the size. The ureter leaves the pelvis obliquely and continues parallel to its wall, closely attached by connective tissue, which has since been dissected away. This resulted in valve action, when the pelvis filled. Doubtless this action was disturbed in turn by distention and descent of the lower pole of the kidney, the upper end being firmly fixed. Intermittent discharge would thus be accomplished. Slow dilatation at the expense of the structure followed this intermittent back pressure. Chronic infection was later added.

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